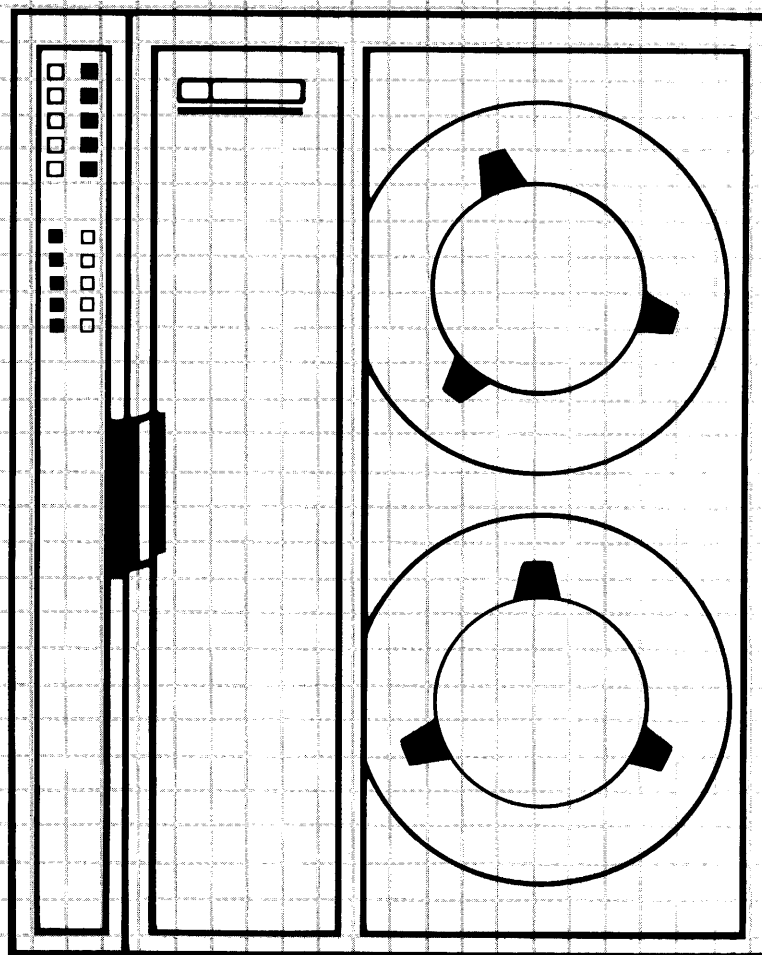


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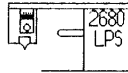
HP-IB INTERFACE MANUAL



Programming and Service

7970E HP-IB INTERFACE MANUAL

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SECTION I. GENERAL INFORMATION

1-1. INTRODUCTION

This manual provides general information for the 7970E Magnetic Tape Unit HP-IB Interface and a programming section, a brief theory of operation and maintenance information.

This section covers general information which includes a general description, identification, and specifications for the 7970E HP-IB Interface.

1-2. DESCRIPTION

The 7970E HP-IB Interface allows a user to operate a 7970E (45 IPS, 1600 bpi, 9TK, PE) Magnetic Tape Drive on a Hewlett-Packard Interface Bus system. It provides the necessary control between the 7970E Magnetic Tape Unit and the HP-IB system controller. Slave operation is also available with the HP-IB option allowing the connection of multiple tape drives to a system through a single HP-IB interface contained in the master tape unit.

The 7970E HP-IB Interface is a factory installed option but it is also available for field installation (using the 26072A HP-IB Conversion Kit).

NOTE

The HP-IB interface does not respond correctly if the tape unit contains Read Motherboard PCAs numbered 07970-62040; the HP-IB interface requires the 07970-63392 Read Motherboard PCA.

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The HP-IB Interface consists of a Control PCA, Write Formatter PCA, a back panel, a Back Panel/Switch PCA, and miscellaneous cables (see figure 5-1, HP-IB Interface Assembly, Exploded View). The Control and Write Formatter PCAs contain the necessary electronics for tape motion and data transfer control.

1-3. IDENTIFICATION

Printed circuit assemblies (PCAs) are identified by a part number and an alphanumeric code consisting of a letter, a series code, and a division code stamped or etched on the assembly (A-1716-46). The letter identifies the version of the etched trace pattern of the unloaded printed circuit board. The four digit series code pertains to the electrical characteristics (circuit design) of the loaded PCA. The division code identifies the Hewlett-Packard division that manufactured the assembly.

1-4. SPECIFICATIONS

The HP 7970E HP-IB Interface is listed by Underwriter's Laboratories, Inc. in the following categories with respective guide designations: Electronic Data Processing Equipment (EMRT), Teaching and Instruction Equipment (WYFW), and Office Appliance and Business Equipment (QOAT).

The Canadian Standards Association has certified this 7970E HP-IB Interface as Data Processing Equipment.

This Tape Unit was designed to meet most European Safety and RFI/EMC standards for Electronic Data Processing Equipment effective prior to 1 July 1978. Any questions concerning regulatory agency compliance should be directed to the local Hewlett-Packard Sales and Service Offices.

The Specifications for the 7970E HP-IB Interface are listed in Table 1-1.

7970E HP-IB INTERFACE MANUAL**TABLE 1-1. SPECIFICATIONS**

*** Electrical Characteristics**

Power required: +5v @ 2.5 amps
 +12v @ 75 ma
 -12v @ 50 ma

All power comes from the standard 7970E power
115 or 230 (+/- 10%) Vac;
50 to 66 hz, single phase;
400 VA, maximum (on high line).

*** Mechanical Characteristics**

Size: Approx. 36 cm x 18 cm (14 in x 7 in) PCA's

Weight: Less than 0.9 kg (2 lb.)

Compatability: This interface requires an HP-IB Read Motherboard
PCA (part no. 07970-62392) for proper operation.

Interface Cable: 6 metre cable

*** Environmental Specifications**

Operating Temp: 0 to 55 Deg. C (32 to 131 Deg. F)

Relative Humidity: 20 to 80% (Non-condensing)

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SECTION II. PROGRAMMING

2-1. INTRODUCTION

This section contains a brief description of the Hewlett-Packard Interface Bus (HP-IB), the magnetic tape HP-IB functions, and programming information. The programming information includes a description of the 7970E HP-IB programming requirements, secondary talk and listen commands, and the reset commands for the tape unit.

If the user is unfamiliar with 7970E HP-IB interface programming, refer to paragraph 2-4, Programming Requirements, for a brief description of 7970E HP-IB Interface programming basics. This section references most of the other programming sections and can act as a guide to the more detailed programming information in the remainder of the section.

2-2. HP-IB DESCRIPTION

The Hewlett-Packard Interface Bus (HP-IB) is a carefully defined instrumentation interface which simplifies the integration of instruments, calculators, and computers into systems. It minimizes compatibility problems between devices and has sufficient flexibility to accommodate future products.

The Hewlett-Packard Interface Bus employs a 16 line bus which is composed of three handshake lines to control data transfer timing, five management lines to control bus operations, and eight data lines for data transfer.

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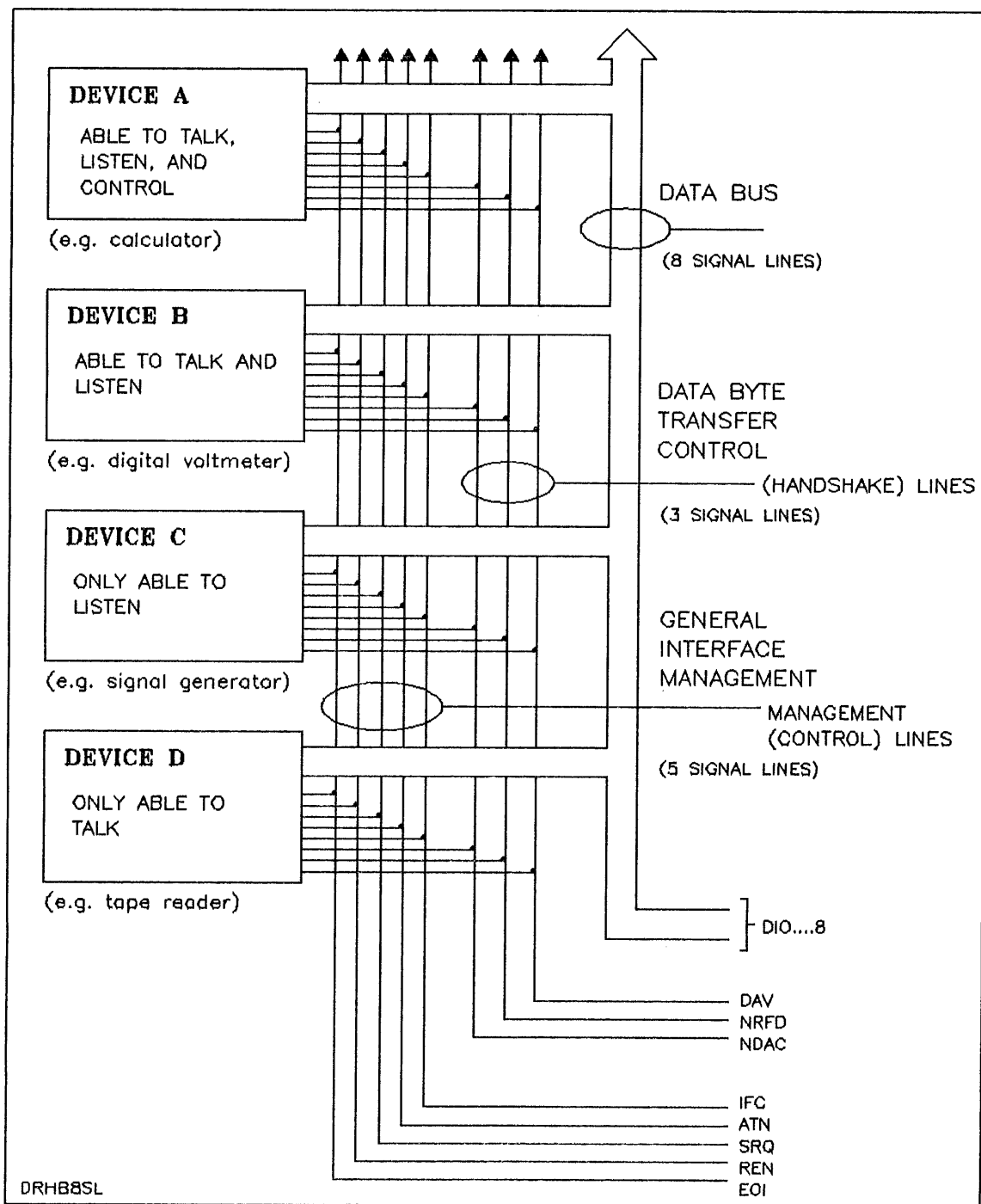


Figure 2-1. Hewlett-Packard Interface Bus Diagram

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To operate a device on the HP-IB requires the device be in one of three HP-IB communication modes (functions): talker, listener, or controller. A controller is a device capable of controlling HP-IB operations. It determines which bus device is serviced and when to service it. Once the controller has determined which device to service, it issues a primary command to that device. The primary command can be either a My Talk Address (MTA) or a My Listen Address (MLA) command. The My Talk Address configures the device to be a talker which enables it to transmit data to the bus and the My Listen Address configures the device to be a listener allowing it to accept data. In these two modes the device is referred to as either a talker (data transmitter) or a listener (data receiver).

Immediately following the primary command the HP-IB controller issues a secondary command. The secondary command, referred to as My Secondary Address (MSA), informs the bus device how to interpret the data bytes that follow the secondary command (refer to table A-2 or A-3). Some secondary commands have a modifier data byte (sent across the bus as data) which is sent immediately following the secondary command to further define the secondary command. The secondary commands are grouped into secondary talk and secondary listen command groups and are sent to the device when it is in the talk or listen mode, respectively.

NOTE

The state of the HP-IB bus ATN (attention) management (control) line determines the status of the DATA lines (DIO 1 through 8). When the ATN line is low (true), the eight data lines are in the command mode; when ATN is high, the data lines are in the data mode. In command mode the information placed on the data lines is considered an HP-IB bus command and when in the data mode the information is considered data.

The HP-IB provides two ways for a bus device to request service. The first method, serial polling (not used in this interface), is initiated when a bus device, requiring service, asserts the Service Request (SRQ) control line. When the controller sees the SRQ line low, it begins a serial poll sequence. This sequence involves selecting (addressing) each device on the bus, one at a time, to find the device that requires service. With this polling method the bus operates with up to 30 devices but, is somewhat slow in that the bus controller must address each device on the bus, one at a time, to locate the one requiring service. A second polling method, parallel

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polling (used by the tape interface), limits the number of devices on a bus to eight and is much faster locating devices requiring service. Each device's bus address (0 through 7) corresponds to one of the eight DIO lines (8 through 1). When the bus controller polls (the bus controller initiates a parallel poll) the bus, any device requiring service asserts the DIO line corresponding to its address. This immediately provides the bus controller with the address(es) of the device(s) requiring service.

All bus devices are provided with a bus address, referred to as the fundamental address, which identifies the device location on the bus. These addresses range from 0 through 7 for parallel polling and 0 through 30 for serial polling. When the controller polls the bus, the devices requiring service respond with their bus address. The controller then embeds the received address of a device requiring service in the primary command (MLA or MTA) that is sent across the bus to address and service that device. For a device to become an active talker or listener the embedded address in the primary command must equal the address of the bus device.

2-3. 7970E HP-IB FUNCTIONS

In addition to the standard handshake capability (Source and Acceptor) the 7970E HP-IB Interface recognizes the Extended talker, Parallel Poll and Device Clear functions. Functions not incorporated are Service Request (SRQ), Remote/Local, Device Trigger, and Controller.

2-4. PROGRAMMING REQUIREMENTS

The following paragraphs describe the general HP-IB software requirements for interfacing a 7970E HP-IB Magnetic Tape Unit to a Hewlett-Packard Interface Bus system. The basic procedure which must be followed when creating a 7970E tape unit system driver is provided.

2-5. Command Sequence

The sequence of HP-IB commands sent across the bus, between the system controller and the HP-IB interface, is shown in figure 2-1 (General Command Sequence). This sequence occurs for either talk or listen mode message sequence. The listen sequence and the talk sequence are discussed briefly in the following paragraphs.

The sequence of HP-IB messages for transferring commands, status, or data is shown in table 2-1.

TABLE 2-1. GENERAL COMMAND SEQUENCE

IFC	- Interface Clear (Untalk or Unlisten may also be used if the previous state of the unit was a talker or listener) is used to unaddress the tape controller (CHI chip).
MLA	- My Listen Address (MLA) or My Talk Address (MTA)
or	(primary commands) commands configure the interface
MTA	to the listen or talk mode.
MSA	- My Secondary Address, is one of several possible secondary commands to define the meaning of the data or modifier byte(s) that follow the secondary command.
DAB	- Data byte(s), associated with the secondary command, consist of one or more bytes and include the tape commands, status, data, loopback, or byte count information.
DAB	
UNL	- Unlisten or Untalk is sent to unaddress the tape
or	controller.
UNT	

For the system controller to transmit commands and status to the HP-IB interface, the HP-IB interface state must be a listener, therefore the system controller must issue the My Listen Address (MLA) primary command. If the device was previously addressed as a talker it must receive an Untalk (UNT) or an Interface Clear (IFC) command before the My Listen Address. Following the listen address (primary command), one of five secondary listen commands (refer to table A-2, Listen Secondary Commands): Tape commands, Data Transfer command, End commands, Device Clear, or Loopback command is sent. Following the secondary the bus should be placed into the data mode and the secondary's data byte(s) (if any) placed on the bus. The data byte(s) contain the actual command to be performed by the

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interface/tape (execution commences upon transfer of the data byte, if used) or the data to be written to tape.

In order for the system controller to receive status and data from the HP-IB interface, the HP-IB interface state must be a talker, therefore the system controller must issue the My Talk Address (MTA) primary command. If the HP-IB interface was previously addressed as a listener, it must receive an Unlisten (UNL) message or an Interface Clear before the My Talk Address (MTA). Following the MTA (primary command), one of the five secondary talk commands (refer to table A-3, Secondary Talk Commands) which include Status, Data Transfer, Byte Count, Device Specified Jump, and Loopback, is sent. Following the secondary command the bus is placed into the data mode and the secondary data byte(s) are placed on the bus. These data byte(s) (refer to tables A6 and A7) contain the actual status information or data to be transferred by the HP-IB interface to the system controller.

2-6. Parallel Poll Response Conditions

If the HP-IB interface requires service, it responds to a parallel poll from the bus controller by asserting the DIO line (8 through 1) which corresponds to its HP-IB address (0 through 7). Table 2-2 shows the relationship of HP-IB addresses to DIO line numbers.

TABLE 2-2. HPIB ADDRESS AND DIO LINE NUMBER RELATIONSHIP

HP-IB ADDRESS	-	0	1	2	3	4	5	6	7
DIO LINE	-	8	7	6	5	4	3	2	1

The following conditions result in a parallel poll response (request for service) by the 7970E HP-IB Interface.

- * Power restored - For any master drive in which the HP-IB interface is connected
- * Drive placed on-line (if Auto-Select, End command, DIO line 3 set).
- * Rewind or Rewind/Go Off-Line command received.
- * Completion of the following commands:

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1. Rewind (Only if End command bit 3 is set. No rewind poll response is issued for a Rewind/Off-Line command completion.)
 2. Forward Space/Backspace a Record/File
 3. Write Gap
 4. Read Record
 5. Read Record Backward
 6. Write Record
 7. Write File Mark
 8. Unit Select
- * Command rejected
 - * Interface busy (a response to issuance of a tape command.)
 - * Data transfer required (reading or writing and half full buffer condition exists).
 - * Tape runaway (6.7 sec. in which no data is encountered on the tape)
 - * DEVICE CLEAR

After each poll response has been recognized by the user, the response must be cleared by reading the Device Specified Jump (DSJ) status (which also clears the DSJ register); or, the poll response and DSJ register may be cleared by using End commands (refer to paragraph 2-15, End Commands). For maximum speed it is recommended that the user read the DSJ.

End commands are used to modify the poll response conditions and include commands to clear the poll response, clear the DSJ register, inhibit poll responses for read bursts during a read operation, and enable poll responses for rewind completion and for placing the tape unit on-line (Auto-Select). These modifications to the poll response conditions are explained in more detail in paragraph 2-15, End commands.

2-7. Buffer Requirements

The HP-IB interface buffer is a 128 byte FIFO (first in, first out) buffer designed to handle burst transfers of 64 bytes or to handshake one byte at a time across the bus at the read/write rate of the tape unit. Handshaking bytes across the bus at the tape unit read/write rate is slow and does not utilize the maximum HP-IB data transfer rate. Burst mode transfers 64 data bytes at a time to the tape unit HP-IB interface buffer to utilize the maximum HP-IB data transfer rate. For a tape read operation using burst mode, the data from tape begins filling the HP-IB interface buffer. When the buffer reaches half-full (64 bytes) a flag (the half-full flag) sets in the HP-IB interface to indicate a poll response condition (data transfer request). The system controller must respond and transfer the 64 bytes from the buffer before the tape read operation fills the remaining 64 bytes of the buffer. If the system controller does not respond, the tape read operation continues to fill the buffer. When the buffer is filled (128 bytes) and data continues coming, a buffer overrun condition results, producing a Timing error. During a tape write operation the system controller sends two consecutive 64 byte bursts to fill the 128 byte buffer. As the tape write operation empties 64 bytes from the buffer, the buffer half-full flag sets, to enable a poll response to request another 64 byte data burst. The system controller must send this next burst before the write operation of the tape unit empties the buffer, otherwise a buffer underrun condition results, producing a timing error condition.

The time to fill or empty half (64 bytes) of the buffer by a tape unit read or write operation is referred to as the critical response time (CRT). The critical response time for a 45 ips tape unit reading or writing 1600 bpi is 890 microseconds.

The system controller must respond to a tape unit data transfer request condition and transfer the next 64 byte data burst within the critical response time in order to avoid a Timing (buffer overrun or underrun) error.

2-8. Transferring Data To Tape

To transfer data to tape (refer to table 2-3 for single burst or block mode command sequence or table 2-4 for burst mode command sequence transfer to tape), the tape interface must be a listener, then the user must initiate a write record operation by sending the listen Tape Command secondary with the Write Record data byte (refer to paragraph 2-14, Tape Commands, Write Record). After the Write Record command has been received by the HP-IB interface but before the tape motors are up to speed, a poll response is asserted with the Device Specified Jump (DSJ) status set to 0, indicating data should

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now be sent. The tape interface should be placed into the talk mode, the DSJ secondary sent (to read the DSJ status) and then the tape interface placed back into the listen mode. The user has approximately 8 msec (for a 45 ips drive) before data must be placed on the bus after the data request poll response is asserted by the HP-IB interface. (This timing requirement applies to the first burst of a burst mode or the start of a block mode data transfer.) If data is not available to the tape unit after the unit has written its preamble, a timing error results. Following the poll response (for data) the Data Transfer (Write) secondary should be issued, and the data placed on the bus within the required time. The data may be transferred to tape in either burst mode or block mode (block mode is the preferred method of transfer).

In burst mode, data is transferred in bursts of 64 bytes (see figure 2-4). Each time the HP-IB interface is ready to accept a data burst, a poll response is issued with the Device Specified Jump (DSJ) status equal to 0. The user has the responsibility of clearing the poll response either by reading the DSJ (preferred method) or by issuing the End command (refer to paragraph 2-15, End Command, DIO line 1 Clear Poll Response and DIO line 5 Clear DSJ). After the response is cleared, the user must issue the Data Transfer (Write) secondary followed by the data burst. The first data byte (of the burst) must be furnished within the critical response time (refer to paragraph 2-7, Buffer Requirements) otherwise a buffer underrun occurs resulting in a Timing error. The first two data bursts are sent one right after the other to fill the buffer. The final data burst, containing 64 or fewer bytes, has the last byte tagged with EOI (End-Of-Information).

In block mode (see table 2-3), data is transferred as a continuous string of data of any length (8192 bytes maximum recommended). The initial 128 bytes are transferred at 1.2 microsec/byte; all successive bytes are transferred at tape drive speed: 13.9 microsec./byte (at 45 ips). Like burst mode, the first data byte (of the burst) must be furnished within the critical response time after the poll response is issued by the interface. But, in block mode, any poll responses (requests for more data) which might occur after the initial poll response should be ignored. Following the last data byte, tagged with EOI, the Clear Poll Responses, End command (DIO Line 1) should be used to clear the data request (poll response, if any) that had been ignored earlier and, the DSJ should also be cleared with the Clear DSJ Register, End command (DIO line 5 set). Poll responses that follow should again be recognized (the write record completed poll response should be recognized next).

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TABLE 2-3. SINGLE BURST OR BLOCK MODE COMMAND SEQUENCE TO TAPE

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	UNT or IFC	Clearing interface for new sequence	
	MLA	LISTEN	
	MSA	Tape Command	A-2
	DAB	Write Record	A-4
	UNL		
* HP-IB Interface Service Request		Request for data. Send within critical response time.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		
	MLA	LISTEN	
	MSA	Data Transfer	A-2
	DAB	Data -	
	.	Up to 64 data bytes for burst	
	.	mode or up to 8192 bytes for	
	.	block mode. During a block mode	
	.	transfer, data (Service) requests	
	.	which occur here should be	
	.	ignored.	
	DAB	Last byte tagged with EOI.	A-2
	MSA	End Command (Optional- for	
		block mode)	
	DAB	Clear Poll Responses	A-5
	UNL		
* HP-IB Interface Service Request		Write Record command completed. Final poll response.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		

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TABLE 2-4. BURST MODE COMMAND SEQUENCE TO TAPE (Page 1 of 2)

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	UNT or IFC		
	MLA	LISTEN	
	MSA	Tape Command	A-2
	DAB	Write Record	A-4
	UNL		
* HP-IB Interface Service Request		Request for data. Send within critical response time.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		
	MLA	LISTEN	
	MSA	Data Transfer	A-2
	DAB		
	.		
	.		
	.	1st Data Burst (64 bytes)	
	.		
	.		
	DAB	End of 1st burst	
	UNL		
* HP-IB Interface Service Request		Request for data.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		
	MLA	LISTEN	
	MSA	Data Transfer	A-2

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TABLE 2-4. BURST MODE COMMAND SEQUENCE TO TAPE (Page 2 of 2)

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	DAB		
	.		
	.	2nd Data Burst (64 bytes).	
	.		
	.		
	DAB	End of 2nd burst	
	UNL		
* HP-IB Interface Service Request		Request for data.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		
	MLA	LISTEN	
	MSA	Data Transfer	A-2
	DAB		
	.		
	.		
	.	Nth Data Burst (64 or less bytes).	
	.		
	.		
	DAB	Last byte tagged with EOI.	
	MSA	End Command (Optional)	A-2
	DAB	Clear poll response (DIO 1)	A-5
	UNL		
* HP-IB Interface Service Request		Write Record command completed. Final Poll Response.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
	UNT		

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For both modes, the Write Record Completed poll response occurs within 16.8 ms., beginning after EOI has been accepted by the interface. Next, the user should read the DSJ: if DSJ=0, no errors were found; if the DSJ=1, an error or unusual status is indicated and the status should be read and the appropriate action taken (refer to paragraph 2-20, Status).

2-9. Transferring Data from Tape

To transfer data from tape (refer to table 2-5 for the single burst or block mode command sequence or table 2-6 for burst mode command sequence), the user must first place the tape into the listen mode (with the My Listen Address), then initiate a tape read operation by sending the Read Record Tape Command secondary (refer to paragraph 2-14, Tape Command, Read Record). The tape unit reads data from the tape and transfers it to the buffer. When the buffer reaches half full, the HP-IB interface responds to a poll (DSJ set to 0), indicating a data transfer is required. Following this response, the tape unit should be placed into the talk mode, the DSJ secondary issued to read the status, and then the Data Transfer (Read) secondary should be sent to direct the HP-IB interface to place data on the bus. The user must initiate the transfer within the critical response time (refer to paragraph 2-7, Buffer Requirements) after the controller buffer is half full. If data transfer is not initiated within the critical response time, a timing error results indicating a buffer overrun. Data transfer may be accomplished using either burst mode or block mode (block mode is the preferred method).

In burst mode (refer to table 2-6), each time the buffer has 64 bytes ready to burst, the HP-IB interface responds to a poll with the Device Specified Jump (DSJ) status set to 0 (indicating data transfer is required). The user must read the DSJ and issue the Data Transfer (refer to paragraph 2-13, Data Transfer) secondary to begin data transfer (within the critical response time). This sequence is repeated for each 64 byte burst. The last burst consists of 64 or less bytes with the last byte tagged with EOI.

In block mode (refer to figure 2-5) the user must still initiate data transfer within the CRT after the first data transfer poll request has been made. The interface can then transfer data continuously at 1.2 microsec./byte for approximately the first 128 bytes (depending on the response time), then at the tape drive rate of 13.9 microsec./byte. for the remaining portion of the record. The last byte is tagged with EOI.

Following the byte tagged with EOI, in either burst or block mode, the user should send the Clear Poll Response, End command (DIO Line 1 set) to clear the "ignored" data poll response (especially for block

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mode). A poll response must be set within 11.7 msec., after the EOI transfer, to indicate completion of the operation. It is now up to the user to read the DSJ; if the DSJ = 0, no errors occurred in the read operation, if the DSJ = 1, it is recommended that the user read the status to determine if a retry is necessary.

TABLE 2-5. SINGLE BURST OR BLOCK MODE COMMAND SEQUENCE FROM TAPE

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	UNT or IFC		
	MLA	LISTEN	
	MSA	Tape Command	A-2
	DAB	Read Record	A-4
	UNL		
* HP-IB Interface Service Request		Request for data. Send within critical response time.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
MSA		Data Transfer (Read)	A-2
* DAB		Data -	
* .		Up to 64 data bytes for burst	
* .		mode or up to 8192 bytes for	
* .		block mode. During a block mode	
* .		transfer, data (Service) requests	
* .		which occur here should be	
* .		ignored.	
* DAB		Last byte tagged with EOI.	
	UNT		
	MLA	LISTEN	
	MSA	End Command (Optional)	A-2
	DAB	Clear Poll Responses	A-5
	UNL		
* HP-IB Interface Service Request		Read Record command completed. Final poll response.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		HP-IB interface returns DSJ	A-6
	UNT		

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TABLE 2-6. BURST MODE COMMAND SEQUENCE FROM TAPE (Page 1 of 2)

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	UNT or IFC		
	MLA	LISTEN	
	MSA	Tape Command	A-2
	DAB	Read Record	A-4
	UNL		
* HP-IB Interface Service Request		Request for data. Send within critical response time.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6
MSA		Data Transfer (Read)	A-2
* DAB		1ST BURST	
* .			
* .			
* .		64 data bytes	
* .			
* .			
* DAB		End of 1st data burst (64 bytes)	
	UNL		
* HP-IB Interface Service Request		Read Record command request for next burst.	
	MTA	TALK	
	MSA	Request DSJ	A-3
* DAB		Tape controller returns DSJ	A-6

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TABLE 2-6. BURST MODE COMMAND SEQUENCE FROM TAPE (Page 2 of 2)

HP-IB Interface Response (*)	PROGRAM MESSAGE SEQUENCE	COMMENTS	Table Reference (Appendix)
	MSA	Data Transfer (Read)	A-2
*	DAB	2nd BURST	
*	.		
*	.		
*	.	64 Data Bytes	
*	.		
*	.		
*	DAB	End of 2nd data burst	
	UNL		
* HP-IB Interface Service Request		Read Record request for next data burst.	
	MTA	TALK	
	MSA	Request DSJ	A-3
*	DAB	Tape controller returns DSJ	A-6
	MSA	Data Transfer (Read)	A-2
	MSA	Data Transfer (Read)	A-2
*	DAB	Nth BURST	
*	.		
*	.		
*	.	64 or less data bytes	
*	.		
*	.		
*	DAB	Last byte tagged with EOI.	
	UNT		
	MLA	LISTEN	
	MSA	End Command (Optional)	A-2
	DAB	Clear Poll Responses	A-5
	UNL		
* HP-IB Interface Service Request		Final poll response - Read Record command completed.	
	MTA	TALK	
	MSA	Request DSJ	A-3
*	DAB	Tape controller returns DSJ	A-6
	UNT		

2-10. Power On and Identify

The tape unit powers up in a reset state. The DIO line corresponding to the device's fundamental address is asserted (poll response) for a parallel poll after interface initialization has been completed. The system controller should acknowledge the device's request and subsequently issue an Identify request (TE function).

The Identify command informs the system controller that the device connected at this address is a 7970E tape storage device. The command sequence for Identify is:

- * UNL/IFC - Unlisten or clear the interface
- * MTA - Issue special primary talk which contains device bus address of 31 (octal)
- * MSA - Issue Identify secondary
- * DAB - Data byte 1 = 10000001
- * DAB - Data byte 2 = 10000011

2-11. Loopback

Loopback verifies the operation of the HP-IB communication link. The Loopback commands, listen mode (refer to paragraph 2-17, Loopback Listen) and talk, (refer to paragraph 2-26, Loopback Talk), are used to transfer known data to the HP-IB interface. The HP-IB interface then transfers the same data back to the system controller. The system controller compares the received data to that which was sent and, if they are not identical, the system controller assumes an error exists on the bus. With loopback it is possible to detect "stuck" data or control lines as well as faulty processor chips. Loopback operation exercises the bus at the maximum data transfer rate and on the HP-IB interface it exercises the CHI, bus transceivers, buffer microprocessor, and handshake logic at operating speed. The message sequence for the loopback secondary is similar to the message listing explained under Command Sequence (see paragraph 2-5, Loopback).

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2-12. SECONDARY LISTEN COMMAND GROUP

The 7970E HP-IB Interface responds to five secondary listen commands (MSA). These secondaries, listed below (also see table A-2), are explained in the following paragraphs.

- * DATA TRANSFER (Write)
- * TAPE COMMAND
- * END COMMAND
- * DEVICE CLEAR
- * LOOPBACK (Listen)

2-13. Data Transfer (Write)

The Data Transfer (Write) secondary (X1100000) directs the interface to prepare for data bytes to be transferred to tape (refer to paragraph 2-8, Transferring Data To Tape). Following this command the bus should be placed in the data mode and the data bytes for storage should be placed on the bus. Prior to issuing this command the tape unit, it must be ready to write (refer to paragraph 2-14, Write Record).

2-14. Tape Commands

The Tape Command secondary (01100001) informs the HP-IB interface that the following data byte represents a command to be performed by the 7970E Tape Unit. These 15 tape commands (in octal) include:

- | | | | |
|-------------------|------|--------------------------|------|
| * Select Unit 0 | - 1 | * Forward Space Record | - 11 |
| * Select Unit 1 | - 2 | * Backspace Record | - 12 |
| * Select Unit 2 | - 3 | * Forward Space File | - 13 |
| * Select Unit 3 | - 4 | * Backspace File | - 14 |
| * Write Record | - 5 | * Rewind | - 15 |
| * Write File Mark | - 6 | * Rewind and Go Off-Line | - 16 |
| * Write Gap | - 7 | * Read Record Backward | - 17 |
| * Read Record | - 10 | | |

If a non-tape command (byte value not equal to one of those listed above) is sent, the HP-IB interface simply ignores the command, set Command Reject status, set the DSJ=1, and assert a poll response. If the drive is rewinding, off-line, or busy, this same response occurs if a motion (any Read, Write, or spacing command) command is issued to the tape drive. If the interface is busy and any tape command is issued, it will be rejected.

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Also, note that all tape commands, with exception of the Rewind and Go Off-Line command, complete their sequence with a poll response. Rewind and Rewind/Go Off-Line issue a poll response when the tape unit begins rewinding. Following the poll response DSJ should be read: if equal to 0, the task was successfully completed; if equal to 1, unexpected status occurred and the user should read the status. The tape commands are explained below for the indicated octal value of the tape command data byte.

a. 1 - Unit Select 0

The Unit Select 0 command (00000001) selects tape unit 0, as indicated by the operator UNIT SELECT switches 0 through 3 (located on the tape drive front panel), for operation. This command also assigns the status information in Status Register #1 and #2 to unit 0 and disables all poll responses from other tape units. It is also possible to automatically select a tape unit when it is placed on-line by issuing the Rewind Completed/Auto-Select, End command (refer to paragraph 2-15, End Commands, DIO line 3).

b. 2 - Unit Select 1

The Unit Select 1 command (00000010) is identical to Unit Select 0 except that unit 1 is selected (refer to 1 - Unit Select 0).

c. 3 - Unit Select 2

The Unit Select 2 command (00000011) is identical to Unit Select 0 except that unit 2 is selected (refer to 1 - Unit Select 0).

d. 4 - Unit Select 3

The Unit Select 3 command (00000100) is identical to Unit Select 0 except that unit 3 is selected (refer to 1 - Unit Select 0).

e. 5 - Write Record

The Write Record command (00000101) begins tape motion and initializes the tape unit for a write operation. This allows the user to write data to tape during a data transfer. This command is issued prior to a Data Transfer secondary (refer to paragraph 2-8, Transferring Data To Tape). At the completion of this command tape motion stops and a poll response is asserted.

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f. 6 - Write File Mark (EOF)

The Write File Mark command (00000110) causes a file mark to be written on tape. The EOF bit in the status word (Register #1) is set to 1 to confirm this operation has completed.

g. 7 - Write Gap

The Write Gap command (00000111) allows the user to forward space and erase approximately 4 inches of tape. This is useful if a section of tape is found where multiple retries fail for a write operation. The user can then skip over that portion of tape and proceed with the write operation. Upon completion of this command the HP-IB interface responds to a poll with the DSJ set 0 to indicate the Write Gap has completed with no errors.

h. 10 - Read Record

The Read Record command (00001000) initiates a tape read operation. A read operation reads data from the tape and places it into the interface buffer (refer to paragraph 2-9, Transferring Data), until a data record or file mark (EOF) is found. After the record is read (indicating the Read Record is completed), the HP-IB interface responds to a poll with the DSJ equal to 0 if no errors occurred. This poll response is the final response indicating the Read Record is complete.

i. 11 - Forward Space Record

The Forward Space Record command (00001001) moves tape in the forward direction until an end-of-record is detected. When an end-of-record is detected, a poll response is asserted with the DSJ set to 0. If a file mark (EOF) is encountered, the DSJ is set to 1 and a poll response for the EOF is asserted when motion stops. Tape motion stops when an end-of-record or EOF is detected but continues running when an EOT is encountered.

j. 12 - Backspace Record

The Backspace Record command (00001010) moves tape in the backward direction until an end-of-record is detected. If the end-of-record is detected, a poll response is asserted with the DSJ equal to 0 and tape motion stops. If a beginning-of-tape (load point) or file mark (EOF) is encountered, the DSJ is set to 1, a poll response is issued, and tape motion stops.

7970E HP-IB INTERFACE MANUAL**k. 13 - Forward Space File**

The Forward Space File command (00001011) moves tape in the forward direction until a file mark is detected and stops. The final position of the tape head is immediately following the end-of-file mark just read and just preceding the next record or file mark. The DSJ is set to 0 and the poll response asserted. If an EOT is detected the DSJ is set to 1, the EOT status is set, and motion continues (no poll response is issued). If an end-of-record is encountered, the DSJ is not affected and motion continues until either a file mark is found or enough tape (without data) has passed for the tape runaway condition to be met. The status bit is updated accordingly.

l. 14 - Backspace File

The Backspace File command (00001100) moves tape in the reverse direction and stops after the first file mark or when beginning-of-tape (load point) is detected. When tape motion stops, a poll response is asserted and the DSJ is set to 0 if a file mark was encountered or the DSJ is set to 1 if a BOT was detected.

m. 15 - Rewind

The Rewind command (00001101) causes the transport to start rewinding at 160 ips. A poll response is asserted to acknowledge that the rewind command was received. When BOT is detected, the tape is positioned at load point and halted. If the Enable Rewind Completion Response/Auto-Select, End command (refer to paragraph 2-15, End Command) has been issued to the HP-IB interface, a poll response is issued at BOT. The rewinding status bit is updated during the next idle state of the HP-IB interface. The interface is now available to control other tape units after the command received poll has been acknowledged.

n. 16 - Rewind and Go Off-Line

The Rewind and Go Off-Line command (00001111) is similar to the Rewind command except that the selected unit is taken off-line after the rewind is completed. No poll response is issued at the completion of this command.

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o. 17 - Read Record Backward

The Read Record Backward command (00001111) reads the tape in the reverse direction until an end-of-record or file mark (EOF) or BOT is detected. After an end-of-record or file mark is read (indicating the Read Record Backward is completed) the tape controller responds to a poll. The user should read the DSJ. If a BOT or an EOF was detected the DSJ is set to 1. If this command is issued at load point, the HP-IB interface responds to a poll with the DSJ set to 1. It should be emphasized that the actual data that is read, is opposite to that which was read in the forward direction, that is, bytes 1,2,3,...,n-1, n read in the forward direction are read as n,n-1,...,3,2,1 in the reverse direction. The bits within the bytes do not change.

2-15. End Command

The End secondary (X1100111) is used to modify the HP-IB interface poll response conditions. It uses a data byte (which follows the End command) select of one of the four End command features. One or any combination of the four End commands may be selected by setting the DIO line corresponding to the feature. These commands, listed below, are explained in the following paragraphs.

- * Clear Poll Responses (DIO Line 1)
- * Inhibit Poll Responses For Read Bursts (DIO Line 2)
- * Enable Rewind Completion Response/Auto-Select (DIO Line 3)
- * Clear DSJ Register (DIO Line 5)
- * Abort Current Tape Operation (DIO Line 6)

All commands, with the exception of DIO line 3, yield an immediate result. (DIO lines 4,7, and 8 are not used and if set represents an invalid command.)

a. 1 - Clear Poll Response

The Clear Poll Response command, enabled when DIO line 1 is set to 1, clears the poll response for the selected tape unit. This command when used in conjunction with the Clear DSJ Register (End command, DIO line 5 set to 1) can be used as an alternative to reading the DSJ (reading the DSJ clears the DSJ register and the poll response). The Clear Poll Response command can be used to clear ignored poll responses issued during a block mode data transfer.

7970E HP-IB INTERFACE MANUAL**b. 2 - Inhibit Poll Responses For Read Data Transfers.**

The Inhibit Poll Responses For Read Data Transfers command, enabled when DIO line 2 is set to 1, inhibits poll responses for read data transfers during a tape read operation. When sent, anytime after the Read command has been issued, it allows the user to recognize the data received prior to the command and ignore all subsequent data in the record. This allows the user to read some portion of the first part of a record and then ignore the remainder. A poll response is asserted at the end of the record with the DSJ set to reflect the appropriate action for the entire record. A timing error will not result for the terminated portion of the record; however, if a timing error did occur in the received portion of the record it is indicated. This command remains valid for the current read record operation only.

c. 3 - Enable Rewind Completion Response/Auto-Select

The Enable Rewind Completion Response/Auto-Select command, selected by setting DIO line 3 to 1, enables the HP-IB interface to issue one poll response for any tape unit (master/slave) that completes a rewind or is placed on-line. When a tape unit is placed on-line with this command enabled, the HP-IB interface automatically selects (auto-select) that unit, provide a poll response for the unit placed on-line, clear the Tape-Unit-X-Has-Been-Placed-On-Line bit in Status Register 3, and set the DSJ to 1. If this End command is issued after a unit has already been placed on-line but has not been selected (serviced), the unit can still be auto-selected.

If the unit completes a rewind with the Enable Rewind Complete Response/Auto-Select command enabled, the HP-IB interface responds to a poll with the DSJ set to 0.

To clear this command either a rewind completion, an auto-select, or one of the select unit commands must occur. The resulting poll response must be acknowledged by reading both the DSJ and the Status secondary (with no commands in between). If this sequence is not observed the same response is repeated for the same tape unit the next time a Enable Rewind Completion Response/Auto-Select, End command is issued.

The HP-IB interface is designed to save both a rewind completed response and a tape-unit-has-been-placed-on-line operation for each of up to four tape units. (The tape-unit placed-on-line action is saved and, when the End command with DIO line 3 set is received, the unit is auto-selected). If the poll response for rewind completion or auto-select are not serviced by the HP-IB

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interface they will be saved for servicing later on. It is possible to save a total of eight responses. Only one command may be issued at a time, until a response is made, then another command may be issued for the next response.

When servicing these "saved" responses the user may have to read up to four DSJs to clear out all possible responses (if desired). Both the rewind completion and the unit-placed-on-line responses are cleared when the unit has been selected. The responses are not returned in the order of their occurrence: rewind completion responses (in the order of units 0 through 3) are returned first, then Auto-Select responses (for units 0 through 3). This priority is always observed for "saved" End (DIO line 3 set) command response servicing.

d. 5 - Clear DSJ Register.

The Clear DSJ Register command, with DIO line 5 set to 1, clears the DSJ register. This command may be used in conjunction with Clear Poll Response, End, command to emulate reading the DSJ (that is, clear the poll response and reset the DSJ register). However, when the End commands are used in this manner the execution time is greater than when the DSJ secondary is used.

e. 6 - Abort Current Tape Operation

The Abort Current Tape Operation command, selected by setting DIO line 6 to 1, stops all tape motion (except rewind). The currently selected unit remains selected and the "saved" poll responses are retained, but the status is reset. No poll response is issued for this command.

2-16. Device Clear

The Device Clear secondary (X1110000) and its data byte are accepted by the HP-IB interface but have no affect on its state. If this command is sent to the HP-IB interface, the data byte may be any value (refer to paragraph 2-29, Device Clear/Selected Device Clear) as it is ignored.

2-17. LOOPBACK

The Loopback (listen) secondary (X11111110) configures the HP-IB interface to accept 256 data bytes of any pattern and store the first 128 bytes in the internal buffer. The remaining data bytes (129 to 256) are discarded. After the 256th byte has been received, the HP-IB interface responds to a poll indicating the transfer is complete (refer to paragraph 2-11, Bus Loopback Test).

2-18. SECONDARY TALK COMMAND GROUP

The HP-IB interface responds to five secondary talk commands. These commands, listed below, are explained in the following paragraphs.

- * Data Transfer (Read)
- * Status
- * Byte Count
- * Device Specified Jump
- * Loopback (Talk)

2-19. Data Transfer

The Data Transfer (Read) secondary (11100000) directs the tape controller to prepare for transferring data to the bus. Following this command the bus should be placed into the data mode. Data may then be transferred in either block (preferred method) or burst mode (refer to paragraph 2-9, Transferring Data From Tape).

2-20. Status

The Status secondary (01100001) directs the HP-IB interface to transfer the contents of its three status registers. Status registers 1 and 2 reflect the status for the selected tape unit and status register 3 reflects HP-IB interface information. The status contained in registers 1, 2, and 3 is transferred in the three data bytes 1, 2, and 3, respectively, that follow the Status secondary. The status information for each register data byte is shown in table 2-7.

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TABLE 2-7. STATUS INFORMATION

Register #1 (Data Byte 1)	Register #2 (Data Byte 2)	Register #3 (Data Byte 3)
On-Line	Interface Busy	Tape Unit 0
Multiple Track Error	Tape Unit Busy	Placed On-Line
File Protected	Rewinding	Tape Unit 1
Command Rejected	Tape Runaway	Placed On-Line
Single-track Error	Data Error	Tape Unit 2
End-Of-Tape	Selected Unit LSB	Placed On-Line
Load Point	Selected Unit MSB	Tape Unit 3
End-Of-File		Placed On-Line
		Command Parity Error
		Power Restored

The following bits are automatically reset after the status has been read: MTE, Command Rejected, STE, Tape Runaway, Command Parity Error, Timing Error, and Power Restored.

2-21. STATUS REGISTER #1

The status bits for status register 1 are explained below. The number associated with the status bit description identifies the DIO line which when set to 1 indicates that status (also see table A-7).

a. 1 - On-Line

The On-Line status bit (DIO line 1), when set to 1, indicates the on-line/off-line status of the selected (indicated by status bits 6 and 7 in register #2) tape unit. This bit is set to 1 when the unit is on-line and to 0 when the unit is off-line.

b. 2 - Multiple-Track Error (MTE)

The Multiple-Track Error (MTE) status bit (DIO line 2), when set to 1, indicates that two or more data tracks were in error during a read or write operation. The MTE status is ignored by the controller until the data transfer is complete. After the last byte is transferred and tape motion halted, the MTE status is set, the DSJ is set to 1, and a poll response asserted.

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Generally, a single-track error (STE) occurs whenever an MTE occurs. But, it is possible during both read and write operations to have only an MTE error occur when the tape format is incorrect (for example, trying to read an 800 bpi NRZI tape). The Multiple-Track Error Status bit is reset after the status is read.

c. 3 - File Protect

The File Protected bit (DIO line 3), when set to 1, indicates that the tape reel on the selected tape unit does not have a write ring installed. If a write is attempted when the File Protect status bit is set, the DSJ is set to 1, the poll response is asserted, the Command Reject status bit is set to 1, and the write operation is not attempted. The File Protect status is valid for the selected tape unit if it is on-line. This bit is reset when the status is read.

d. 4 - Command Rejected

The Command Rejected bit (DIO line 4), when set to 1, indicates that the command issued to the HP-IB interface has been rejected. If any tape command is issued to the tape unit while the Interface Busy status bit is set, the command will be rejected. Any attempt to perform a motion operation on a selected device while a rewind or other operation is in progress causes a command to be rejected. Also, if a write operation is attempted on a file protected drive, the command is rejected. When a command is rejected, the DSJ is set to 1 and the poll response asserted for this error. The Command Rejected status bit is reset when the status is read.

e. 5 - Single-Track Error (STE)

The Single-Track Error (STE) bit (DIO line 5), when set to 1, indicates a parity error was detected in one track on tape. A Single-Track Error during a read operation is corrected by the tape unit. The STE status and DSJ bits are set to 1. A poll response is asserted at the end of the read/write operation (after the EOI has been received). After a write operation with an STE, the actual data on tape is in error. Although the tape electronics can correct this error during a read operation, the chances for a multiple-track error are increased. It is recommended that the record be rewritten whenever an STE is detected after a write operation. The STE status bit is reset after the status is read.

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f. 6 - End-Of-Tape (EOT)

The End-Of-Tape (EOT) bit (DIO line 6), when set to 1, indicates the End-Of-Tape marker has been detected. When an EOT is detected on the selected drive, the EOT status bit is set to 1, and the DSJ status bit is set to 1 for the final poll response, tape motion normally continues after the EOT has been read. The EOT bit remains asserted and the DSJ is set to 1 until the EOT marker is read during a reverse motion operation or a rewind operation is executed.

g. 7 - Load Point (LP)

The Load Point (LP) bit (DIO line 7), when set to 1, indicates the selected device is at Load Point. If load point is detected during a backspace or a read backward operation, the DSJ is set to 1. This bit is reset when the tape moves off the beginning-of-tape (BOT) marker.

h. 8 - End-Of-File (EOF)

The End-Of-File (EOF) bit (DIO line 8), when set to 1, indicates that the selected unit detected a file mark. The DSJ status bit is set to 1 if a Read, Forward Space Record, or Backspace Record command has been issued or if a Forward Space File or Backspace File command was issued the DSJ is set to 0. The EOF bit is reset when the status is read.

2-22. STATUS REGISTER #2

The status bits for status register 1 are explained below. The number associated with the status bit description identifies the DIO line which when set to 1 indicates that status (also see table A-7).

a. 1 - Interface Busy

The Interface Busy bit (DIO line 1), when set to 1, indicates that the HP-IB interface is busy executing another command. When the currently selected device is executing a motion command other than rewind, the HP-IB interface is considered busy. If a rewind is in progress for the selected device, the user may select a different device and initiate motion. If a motion command is

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issued to a device currently in a rewind mode, the command rejected bit is set to 1, the DSJ is set to 1, and the poll response asserted. The user can request status regardless of the setting of the interface busy bit.

b. 2 - Tape Unit Busy

The Tape Unit Busy bit (DIO line 2), when set to 1, indicates that a tape motion command is in progress. This bit can be used to determine when the drive is available for additional commands. It is reset when the tape unit completes the current command.

c. 3 - Rewinding

The Rewinding bit (DIO line 3), when set to 1, indicates that a Rewind command has been received and is being executed by the tape unit. The bit is reset when the transport is at load point (BOT) and ready to accept additional commands or is off-line (possibly because of Rewind and Rewind/Go Off-Line command).

d. 4 - Tape Runaway

The Tape Runaway bit (DIO line 4), when set to 1, indicates that the selected device has read approximately 7.6 meters (25 ft) of tape without detecting a byte of data. At that point tape motion stops, the DSJ sets to 1, the Tape Runaway status bit is set to 1, and a poll response is asserted. Tape runaway is detected for Read/Write Record and Forward or Backward Space Record/File commands. This bit is reset automatically after the status has been read.

e. 5 - Data Timing Error (DTE)

The Data Timing Error (DTE) bit (DIO line 5), when set to 1, indicates that a data buffer overrun or underrun condition has occurred (refer to paragraph 2-7, Buffer Requirements). That is, the tape controller was required to accept or provide data on the bus and data was not available or not previously accepted by the user. If a timing error occurs during a read operation, it is possible for the last byte (tagged with EOI) to be deleted. This could cause a data transfer timeout to occur on the bus because of the lost EOI. The DSJ is set to 1 for the final poll response issued for the read/write completion. The DTE is reset automatically after status has been read.

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- f. 6 - Selected Tape Unit (Least Significant Bit)
- 7 - Selected Tape Unit (Most Significant Bit)

The Selected Tape Unit bits (DIO lines 6 & 7) represent, in binary, the tape unit that is currently selected (0 through 3). All of the status bits in registers 1 and 2 reflect the status of the selected tape unit. If no unit is selected these Selected Tape Unit bits remain 0, indicating unit 0 is selected which is not the case. Status register 1 (byte 1) indicates whether a unit is selected.

2-23. STATUS REGISTER #3

The status bits for status register 1 are explained below. The number associated with the status bit description identifies the DIO line which when set to 1 indicates that status (also see table A-7).

- a. 1 - Tape-Unit-0-Placed-On-Line

The Tape-Unit-0-Placed-On-Line bit (DIO line 1), when set to 1, indicates that tape unit 0 (or unit 1, 2, or 3) has been placed on-line but has not been selected (serviced) since it came on-line. As soon as the unit is selected this bit is reset to 0.

If the Enable Rewind Complete Response/Auto-Select, End (DIO line 3 set) command has been issued and the operator places a tape on-line (anytime after receipt of this End command), the HP-IB controller auto-selects the unit and the tape units unit select number is indicated by Status Register #2 (bits 6 and 7). This auto-select occurs as soon as the HP-IB interface becomes idle. Since the unit has been selected the HP-IB interface responds to a poll with the DSJ equal to 1. When reading the DSJ, the status must also be read (refer to paragraph 2-15, End Commands, Enable Rewind Complete Poll Response/Auto-Select).

- b. 2 - Tape-Unit-1-Placed-On-Line

The Tape-Unit-1-Placed-On-Line bit (DIO line 2) is similar to Tape-Unit-0-Placed-On-Line except that tape unit 1 has been placed on-line (refer to DIO line 1 -Tape-Unit-0-Placed-On-line).

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c. 3 - Tape-Unit-2-Placed-On-Line

The Tape-Unit-2-Placed-On-Line bit (DIO line 3) is similar to Tape-Unit-0-Placed-On-Line except that tape unit 2 has been placed on-line (refer to DIO line 1 -Tape-Unit-0-Placed-On-Line).

d. 4 - Tape-Unit-3-Placed-On-Line

The Tape-Unit-3-Placed-On-Line bit (DIO line 4) is similar to Tape-Unit-0-Placed-On-Line bit except that tape unit 3 has been placed on-line (refer to DIO line 1 -Tape-Unit-0-Placed-On-Line - above).

e. 5 - Command Parity Error

The Command Parity Error bit (DIO line 5) is set to 1 whenever DIO lines 1 through 8 contain even parity as received by the tape controller for a bus command transaction. (parity is not observed for data transfers). Normal command parity is odd (on DIO lines 1 through 8). A command parity error sets the DSJ to 1 and a poll response is asserted. This bit is reset after the status is read.

f. 6 - Power-Has-Been-Restored

The Power-Has-Been-Restored bit (DIO line 6) is set to 1 whenever power is applied to the interface, either during the normal power up sequence with the on/off switch or during a power fail/recovery sequence. In either case, when power is restored to the HP-IB interface, a poll response is asserted with the DSJ set to 1. When the status is read by the user, this bit is reset. This status bit could also be used to indicate that an IDENTIFY (refer to paragraph 2-10, Power On and Identify) should be performed by the user.

2-24. Byte Count

The Byte Count secondary (X1100010) provides the number of data bytes read from or written to the tape during a read or write operation. Two data bytes are returned for this secondary. The first byte represents the most significant value of the byte count and the second byte represents the least significant value.

2-25. Device Specified Jump (DSJ)

The Device Specified Jump (DSJ) secondary (X1110000) is a summary of the detailed three-byte status (from the status registers). It provides a quick indicator for the correct completion or failure of a command operation. The DSJ data byte value is either 0 or 1. When a value of 0 is returned, it indicates that no errors have occurred for the command in progress or the just-completed command and additional status is not necessary. When a value of 1 is returned, a prior command has resulted in an error, abnormal termination, or unexpected results (for example EOT or BOT was encountered for Forward Space/Backspace Record/File). If the DSJ data byte is equal to 1, the three-byte status should be read for a more specific error indication.

2-26. Loopback (Talk)

The Loopback secondary (X1111110) when received in the talk mode, configures the HP-IB interface to return the first 128 data bytes received during Loopback listen. An additional 129th byte with a fixed value (octal 177) is also sent as the last byte.

2-27. RESET COMMANDS

The reset commands return the tape to a reset or idle state, waiting for the next operation to start. Each command resets a different portion of the HP-IB interface. Three reset commands, Interface Clear, Device Clear/Selected Device Clear, and Untalk/Unlisten, are explained in the following paragraphs.

2-28. Interface Clear

The Interface Clear (IFC) command is used only to unlisten or untalk the HP-IB interface (unaddress the CHI). It is not used to reset any of the HP-IB interface hardware. If a reset of the HP-IB interface is desired (hardware and firmware) the IFC must be followed by a Selected Device Clear (or Device Clear).

2-29. Device Clear/Selected Device Clear

The Device Clear/Selected Device Clear (DCL/SDC) commands are used to initialize the HP-IB interface to a predefined state (Power-Up). Both, Device Clear and Selected Device Clear, have the same meaning to the HP-IB interface. The hardware and firmware are reset upon receipt of the DCL or SDC commands. Upon completion of a Device Clear or Selected Device Clear command, the interface asserts a poll response. The DCL does not affect the the current state (talk/listen) of the CHI.

2-30. Untalk/Unlisten

The Untalk and Unlisten commands (similar to IFC) are used to untalk or unlisten the tape unit. This involves unaddressing the CHI chip, but does not reset any of the HP-IB interface electronics.

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SECTION III. THEORY OF OPERATION

3-1. INTRODUCTION

There are four major areas within the interface, control and logic, CHI, buffer, and write formatter (see figure 3-1). Each section interacts with the others to allow transfer of drive commands, status information, and data to and from the HP-IB bus for 7970E operation. The following description assumes some knowledge of HP-IB and HP 300 protocol.

3-2. CONTROL AND LOGIC

The microprocessor (NANO) provides control for interface/tape operations by interpreting bus commands and monitoring interface and tape operations. The processor maintains in its 16 internal registers the operating status, programmed activity, buffer information and data routing information. This information, together with HP-IB bus commands received from the CHI, and program instructions contained in the PROM, allow the microprocessor to generate the required instructions for interface/tape operation. The processor provides the timing for certain operations (Gap, Interrecord Gap, ramp times, ect...) by sampling the output of a crystal controlled timing circuit. The control section I/O registers provide interfacing to the tape drive through the Control and Status PCA (FWD, REV, HSFWD, SELECT, ect...), the Read Motherboard PCA (TM, EOB, STE, IDB, ect.), and the Write Motherboard PCA (SWS, WC, ect.).

3-3. BUFFER

The buffer provides 128 bytes of storage to allow equalization of the different data transfer rates between the HP-IB bus and the tape unit. The tape unit (45 ips at 1600 bpi), can handle data at 72 KHz while the bus transfer rate is 800 KHz. When data is transferred from the bus to the tape unit for storage, the buffer is initially

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filled with one 128 byte burst at 800 KHz. The tape begins removing this data from the full buffer. The remaining data is transferred across the bus at 72 KHz, keeping the FIFO buffer full until the last byte is transferred. The last data byte is tagged with an EOI to indicate the end of data transfer. Movement of data from the tape storage to the bus is the reverse of the above procedure, that is, the buffer is filled by the tape and emptied by the bus.

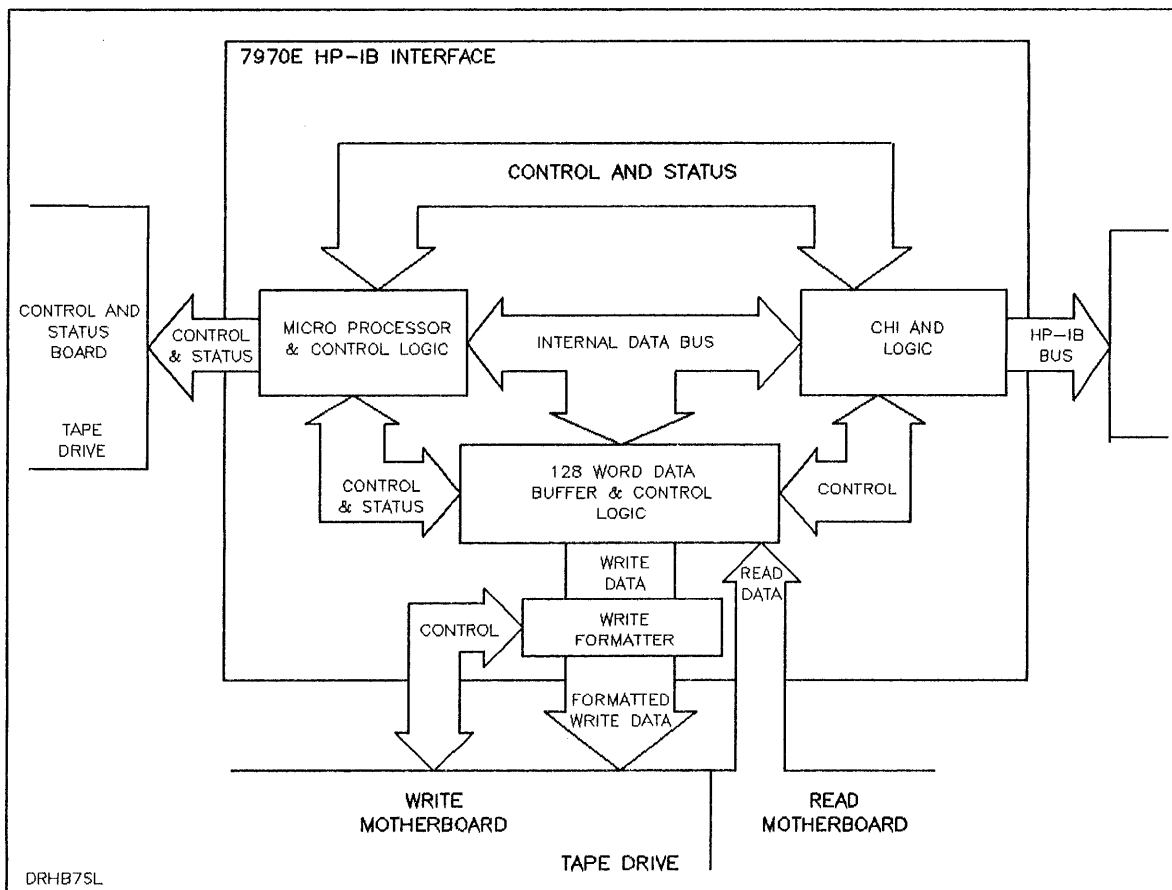


Figure 3-1. 7970E HP-IB Interface Block Diagram

3-4. CHI

The CHI (chip for HP-IB interfacing) interfaces the HP-IB interface assembly to the HP-IB bus. It controls the handshake operation which verifies each data or command byte sent across the bus. It should be noted that the word "data" may refer to either data information for storage on tape or command data which includes commands and status information used for the operation of the tape unit. The CHI directs the transfer of data (data to or from storage on tape), after initialization by the processor, to the buffer or automatically relay HP-IB bus commands and data (tape commands) to the processor. The CHI provides service requests when the interface has been addressed and a level of interpretation to the HP-IB commands on the bus.

3-5. WRITE FORMATTER

The write formatter circuitry, located on the Formatter PCA, provides timing signals for the processor and tape unit, accepts write commands from the processor, generates identification bursts, pre-and postambles, Tape Marks on command, and provides write formatter status signals for the processor. The synchronization timing signals consist of Write Clock (WC) timing signal for the tape unit and a 900 KHz clock signal for the processor. The write command signals from the processor consist of Write Enable, Write Identification Burst, Write Tape Mark, Write Preamble, and End-Of-Data signals. The status signals applied to the HP-IB interface consist of Ready signals and Data Accepted signals.

3-6. POWER SEQUENCE

The power sequence circuitry, located on the Control PCA, ensures that the HP-IB interface does not compromise tape integrity as a result of power failures. To prevent possible data loss due to power failure, the power sequence circuitry shuts down the interface processor and takes the tape unit off-line at the first sign of a possible power fluctuation. To provide this, the power sequence circuit monitors the +12, -12, and +5 supply voltages from the Power Distribution Assembly. These voltages are fed into the +12, -12, and +5 volt comparators (refer to figure 3-2. Power Sequence Block Diagram) on the Control PCA. If these voltages drop below acceptable levels, the comparator output goes low. A low output from any comparator activates the sequence control circuits to assert an interrupt (see figure 3-3, Power Sequence Waveform Timing Diagram) to the microprocessor on the interface and set the Off-Line signal to low which transfers the tape unit to the off-line state (the ON-LINE light on the operator control panel on the tape unit goes out).

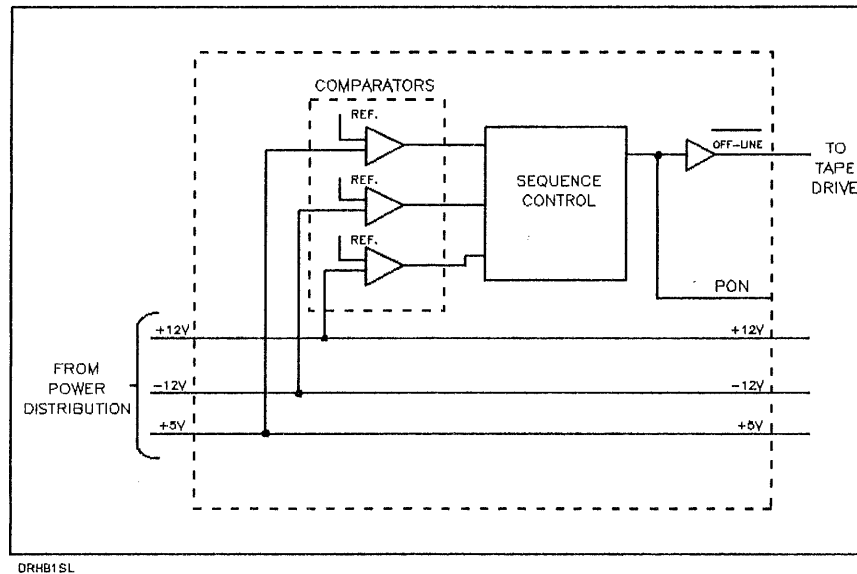
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Figure 3-2. Power Sequence Circuitry Block Diagram

When all three voltages (+12, -12, and +5) return to acceptable levels, the power sequence circuitry eliminates the power-on interrupt to the interface and then switches the Off-Line signal high again. The operator must manually load and place the tape unit back on-line by pressing the ON-LINE switch on the 7970E operator control panel.

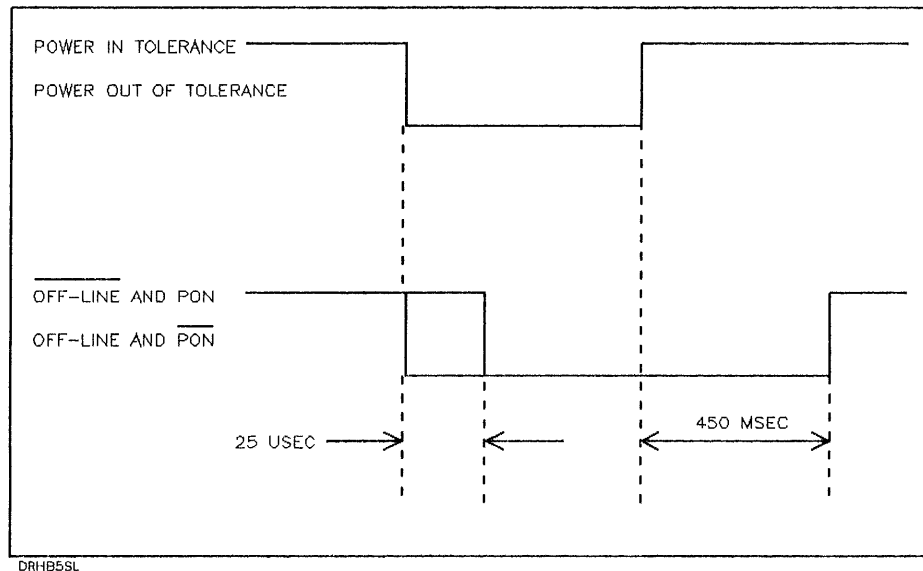


Figure 3-3. Power Sequence Waveform Timing Diagram

SECTION IV. MAINTENANCE

4-1. INTRODUCTION

This section covers maintenance information for the 7970E HP-IB Interface. This information includes cable connection, slave operation, installation and removal of the interface assembly from the tape unit, troubleshooting, maintenance mode information, and LED display information.

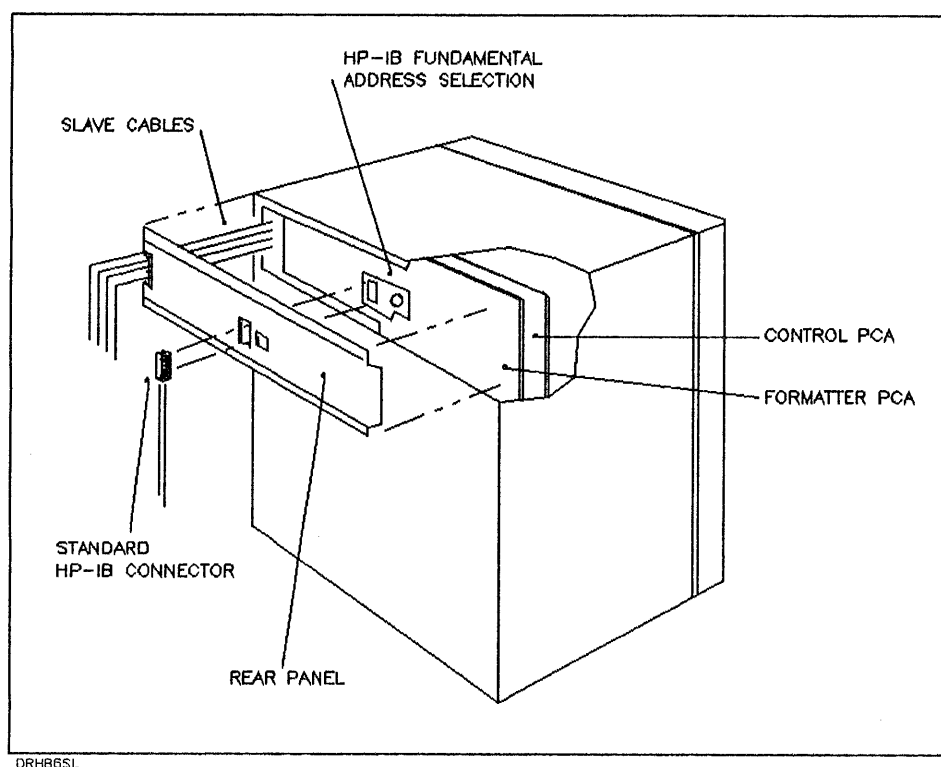


Figure 4-1. HP-IB Cable Connection

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4-2. CABLE CONNECTION

The HP-IB cable is attached to the back of the interface assembly which is accessible from the back of the tape unit (see figure 4-1). To connect the cable, insert it into the HP-IB connector (J6) and tighten the two thumb screws.

Up to six metres of cable can be used to connect the HP-IB tape unit to the system controller. If more six metres of cable is installed, possible data loss can result and/or a reduction in data transfer rate. Do not exceed six metres of cable in any installation.

4-3. SLAVE OPERATION

The 7970E HP-IB Interface Assembly performs the standard unit select function to allow the connection of multiple drives to the master unit. When connecting cables between tape units refer to the appropriate cabinet manual for information concerning cable routing. Figure 4-2 shows a multiunit cable connection with two read-after-write slaves connected to a master (cabinets are rotated to illustrate lo-boy cabinet installation).

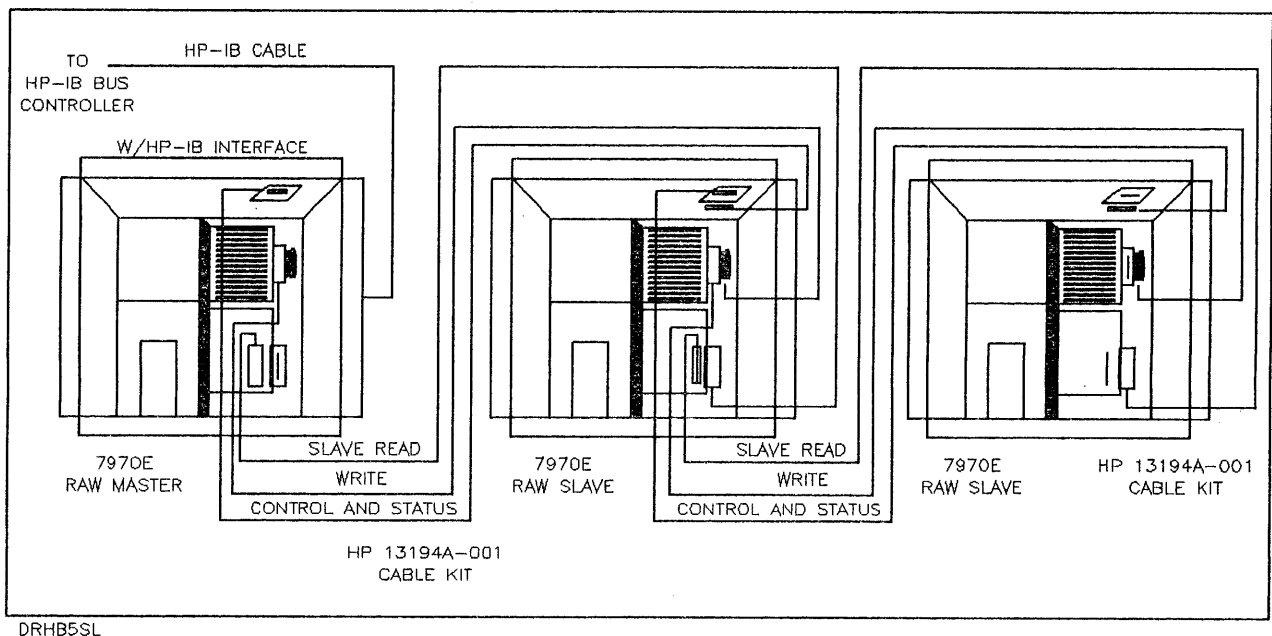


Figure 4-2. 7970E HP-IB Multiunit Configuration

7970E HP-IB INTERFACE MANUAL**4-4. INSTALLATION AND REMOVAL**

The interface PCAs and the backplane assembly are connected together and installed into the tape unit as a unit. To remove the HP-IB interface (07970-62456) complete the following steps.

- a. Disconnect power to the tape unit by setting the tape unit cabinet breaker to off (0) or, if the cabinet does not provide disconnect capabilities remove the ac line plug from the ac line receptacle.
- b. Open the tape unit casting door (upright cabinets only).
- c. Remove the HP-IB cable from the rear of the unit and if installed, disconnect the slave cables from the tape unit.
- d. Remove the HP-IB interface power cable from the Control PCA connector J5.
- e. Remove the hold-down screw from the Control PCA (located above the Read Motherboard Assembly).
- f. Remove the control and status ribbon cable (and the Connector Adaptor PCA) from the Control and Status PCA.
- g. Release the barbed standoffs and swing the Control PCA up and out of the way. The barb portion of the standoff consists of a single barb. To release the barb press it in while pulling outward on the Control PCA.
- h. Remove the ribbon cables (and Connector Adaptor PCAs) from the Write Motherboard Assembly and the Read Motherboard Assembly.
- i. From the rear of the tape unit remove the screws at the four corners of the HP-IB panel and pull the HP-IB assembly from the tape unit.

Install the HP-IB assembly in reverse order of the above removal procedure. When an HP-IB assembly is installed into a 7970E tape unit make sure that the two jumpers, located at the upper left corner of the Read Motherboard Assembly (07970-62392), are installed.

4-5. TROUBLESHOOTING

Due to the complexity of the 7970E HP-IB Interface Assembly component level field troubleshooting is difficult. If the operation of the interface is in question, PCA level substitution should be made.

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If the interface is suspected of containing an error, first make a visual check of the interface. Check the following items:

- a. Make sure all cable connections are aligned correctly and securely seated.
- b. Ensure that the HP-IB address switch is set to the correct address number.
- c. Check the +5 volts on the Control PCA at the +5 test point.
- d. Use maintenance mode (refer to paragraph 4-6, Maintenance Mode) to assist in identifying the error by running the various tests with the stop-on-error condition set.

4-6. Maintenance Mode

The HP 7970E HP-IB Interface Assembly (07970-62456) is equipped with a maintenance mode feature to allow the user to perform certain tape operations off-line. These operations include read and write record, identification burst, file, gap, and forward space and backspace file or record. Maintenance mode tests allow the user to test the 7970E Magnetic Tape Unit perform most of the operations previously performed by the 7970E test accessory PCAs, thus, in most cases eliminating the need for these PCAs (the 7970E test accessory PCA can still be used if desired). (Maintenance mode exercises most of the HP-IB interface).

Maintenance mode is accessed by means of an eight-switch DIP switch (S1) located on the Control PCA. Operation of maintenance mode and a detailed description of the switch selections is provided in the following paragraphs.

CAUTION

When finished using maintenance mode and the tape unit is returned to system operation, make certain the maintenance mode enable switch (S1-1) is set to off (open), and the tape unit is powered off, and then back to on. If this procedure is not followed possible data loss can result when the tape unit is returned to service.

Maintenance mode can be used to provide signals for troubleshooting malfunctions in the tape unit. Using an oscilloscope the user can trace signals using standard troubleshooting techniques.

4-7. Maintenance Mode Operation

Maintenance mode operation is described in the following steps.

- a. Set the tape unit (master drive) power to off (0).
- b. Load a blank (scratch) tape onto the tape unit to be tested.
- c. Set the Unit Select switch to 3 (on the tape unit to be tested).
- d. Set the Enable Maintenance Mode switch (S1-1) to 1 (closed) and select the desired maintenance mode configuration and test selection switches (see paragraph 4-8).
- e. Set the tape unit (master drive) power to on (and set the power to on for the drive to be tested if other than the master unit).
- f. Place the tape unit on-line (press ON-LINE) and the maintenance mode test should begin.

To switch from one maintenance mode test to another take the master tape unit off-line (press RESET), select the new test number on the test selection switches, and place the unit back on-line (press ON-LINE). When in single-step mode and it is desired to perform the test again or to continue testing after the stopping on an error (switch S1-2 set to 1), take the tape unit off-line (press RESET) and then place it back on-line (press ON-LINE).

Single-track errors, multiple-track, and tape runaway are identified by maintenance mode as errors. If these errors occur in the tape unit they will be detected by maintenance mode (testing stops if the stop-on-error is set to 1).

To observe status, if a oscilloscope is not being used it may be convenient to install a 7970E Read Test Accessory PCA to observe the LED indicators.

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NOTE

Ramps can be checked and adjusted by selecting operation 12 (WRT/BSR) and looping (switch S1-4 set to 0). Also, the read preamplifiers can be checked and adjusted by performing operation 1 (write 1600 frpi).

It is possible to erase the entire tape by selecting operation 7 (GAP).

Any improperly written blocks on a tape can be found by selecting the read function with the stop-on-error condition set.

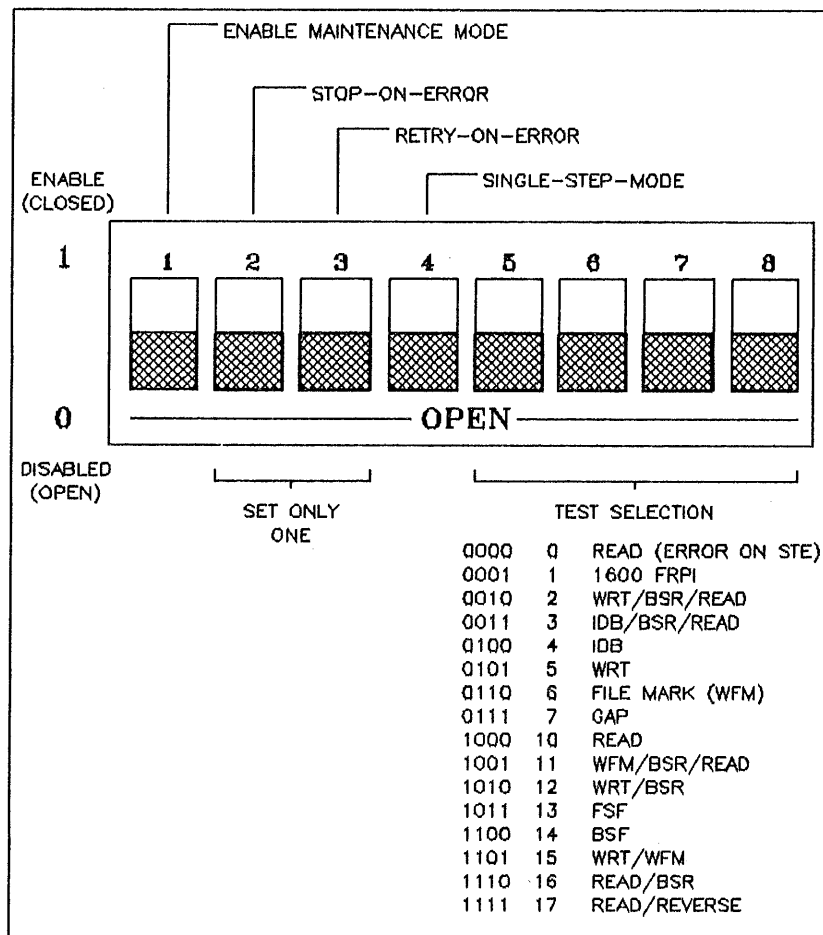


Figure 4-3. Maintenance Mode Switch

4-8. Maintenance Mode Switch Description

A detailed description of the maintenance mode switches is provided below.

a. Switch 1 - Maintenance Mode

The Maintenance Mode switch, when set to 1 (closed), enables maintenance mode. This is accomplished by setting the tape unit power off, setting the maintenance mode switch to 1 (on), and then applying power to the tape unit (refer to paragraph 4-7).

b. Switch 2 - Stop-On-Error

When the Stop-On-Error switch (S1-2) is set to 1 (closed) and an error (see explanation for switch 3) is detected operation terminates and tape motion stops. To continue the operation press the RESET and ON-LINE operator switches.

When the switch is set to 0 (open) the selected operation is completed without regard to the occurrence of errors.

c. Switch 3 - Retry-On-Error

When the Retry-On-Error switch (S1-3) is set to 1 (closed) then, when an error (MTE for read or STE and MTE for write operations) is detected the tape unit repositions the tape and performs the write or read operation again. There is no limit to the number of retries, as long as the error occurs the operation tries to read or write the record, file mark, or identification burst again. If the stop on error switch (S1-2) is set, do not set the retry-on-error switch; only one of these modes should be enabled at a time.

When the Retry-On-Error switch is set to 0 (open) the selected operation does not retry if an STE or MTE is detected (retry is not valid for tape spacing or gap operations).

d. Switch 4 - Single-Step Mode

When the Single-Step switch is set to 1 (closed) any selected operation is performed once. If an error is detected the operation can continue, stop on the error, or retry depending on the setting of switches 2 and 3. To perform the operation again

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take the tape unit off-line (press RESET) and then place it back on-line (press ON-LINE).

When the Single-Step switch is set to 0 (open) maintenance mode loops on the currently selected operation.

e. Switches 5-8 - Operation Selection

Switches 5 through 8 are used to select (in octal) one of sixteen possible operations (0 through 15). To enable any of these tests or operations set the switches (refer to figure 4-3) to the desired octal test number. A description of each test is given below.

1. TEST 00 - READ

Test 00 reads one record. If either a single-track error or a multiple-track error is detected the operation stops on the error (provided S1-2 is set). Normally, during a read operation, when a single-track error is detected it is corrected and the read operation continues.

2. TEST 01 - 1600 FRPI

Test 01 is a write operation which writes 1600 flux reversals per inch (FRPI) in all nine tracks. This operation ignores the settings of the maintenance mode configuration switches (S1-2, 3, and 4).

3. TEST 02 - WRT/BSR/READ

Test 02 writes a 5K record of all the same byte (the byte value can vary and depends on the first byte encountered from the buffer) then backspaces over the record (BSR) and reads it.

4. TEST 03 - IDB/BSR/READ

Test 03 writes an identification burst (IDB), backspaces (BSR) over it, and then reads it to set the IDB status.

5. TEST 04 - IDB

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Test 04 writes one identification burst which consists of writing 3.5 inches of all 0s in the parity channel.

6. TEST 05 - Write

Test 05 writes a 5K record of the same byte (the byte value varies and is determined by the value of the first byte read from the buffer). If an error (STE, MTE, tape runaway) is detected the appropriate action is taken as determined by the setting of the configuration switches.

7. TEST 06 - File Mark

Test 06 writes a file mark. A file mark writes 112 flux reversals in channels P, 0, 2, 5, 6, and 7.

8. TEST 07 - Gap

Test 07 initiates a tape gap operation. The gap consists of the tape unit ramping up and erasing approximately four inches of tape. Since no error status exists for the gap operation the retry switch function does not apply to this operation.

9. TEST 10 - Read

Test 10 reads one record. If a multiple-track error is detected and considered a maintenance mode error, the appropriate action will be taken. If a single-track error is detected it is corrected as in normal operation of the tape unit and the operation completed. Single-track errors are not considered errors for read operations.

10. TEST 11 - WFM/BSR/Read

Test 11 writes a file mark (WFM), backspaces (BSR) over it, and then reads it to check the file mark status.

11. TEST 12 - WRT/BSR

Test 12 writes (WRT) a 5K record of all one byte (the byte value can vary and depends on the first byte encountered from the buffer) then the unit back spaces over the record (BSR) and stops.

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12. TEST 13 - FSF

Test 13 forward spaces one file (FSF). This operation can be used to locate a specific file with the retry configuration switch in single step and taking the tape unit off-line (press RESET) and then on-line (press ON-LINE) by using the operator panel switches.

13. TEST 14 - BSF

Test 14 back spaces one file (BSF). A retry is not valid for a spacing operation.

14. TEST 15 - WRT/WFM

Test 15 writes (WRT) a 5K record of all the same byte (the byte value varies depending on the first byte encountered from the buffer), then it writes a file mark (WFM).

15. TEST 16 - Read/BSR

Test 16 reads one record and then backspaces (BSR) over the record.

16. TEST 17 - Read Reverse

Test 17 reads tape in the reverse direction. If the beginning-of-tape (BOT) is detected the tape unit goes off-line.

4-9. LED INDICATORS

Two four-LED arrays are located on the Control PCA. These eight LEDs are used primarily for factory testing but might prove to be of some assistance field troubleshooting. The function of each LED is shown in figure 4-4 and an explanation of each LED is given below.

a. Talk

The Talk LED illuminates when the tape interface is addressed as a talker (to transmit data and status).

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b. Listen

The Listen LED illuminates when the tape interface is addressed as a listener (to receive data or commands).

c. Receive Ready

The Receive Ready LED illuminates when the tape interface first-in-first-out (FIFO) buffer is ready to receive data.

d. Transmit Ready

The Transmit Ready LED illuminates when the tape interface FIFO buffer is ready to transmit data.

e. Parallel Poll

The Parallel Poll LED illuminates when the tape unit requires service for some reason (to receive or transmit data, report an error condition, report units placed on-line or rewind complete).

f. On-Line

The On-Line LED illuminates when the tape unit is on-line.

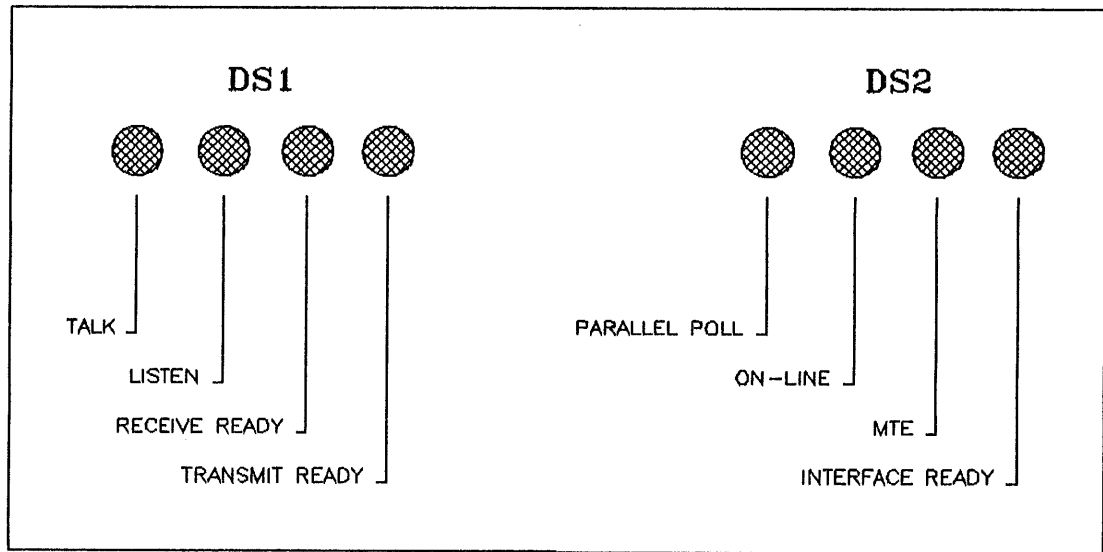
g. MTE

The MTE LED illuminates when a multiple-track error is detected.

h. Interface Ready

The Interface Ready LED illuminates when the interface is not busy or is in the idle state monitoring on-line and rewind status.

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DRHB3SL

Figure 4-4. LED Signal Names

SECTION V. PARTS AND DIAGRAMS

5-1. INTRODUCTION

This section of the manual contains location diagrams, illustrated parts breakdowns (IPB's), and replaceable parts lists for the 7970E HP-IB Interface. Special product configurations or changes made since the printing of this manual are described by updating supplements supplied with this manual.

5-2. DESCRIPTION OF PARTS LIST

The heading for each parts list contains all assembly parts numbers (with applicable series codes) covered by that list. The first entry of the parts list indicates the main assembly on which the list is based. The columns in the parts list furnish the following information for each part:

a. REF. DES./INDEX NO.

This column lists the reference designator or index number (callout number) which identifies each part in the appropriate logic diagram, parts location diagram, or IPB. Asterisks are entered to the left of any entry which varies from the basic parts lists. Entries are arranged alphanumerically.

b. DESCRIPTION.

This column gives the name and a brief description of the part.

c. HP PART NO.

This column lists the Hewlett-Packard part number for each part.

7970E HP-IB INTERFACE MANUAL**5-3. PARTS ORDERING PROCEDURE**

To order parts from Hewlett-Packard, or to obtain further information about parts, address the order or inquiry to the nearest Hewlett-Packard Sales and Service Office. When ordering from Hewlett-Packard give the following information on each part:

- a. Model and serial number
- b. Hewlett-Packard part number
- c. Description of part
- d. Circuit reference designator or index number, if applicable
- e. If the part is installed on a PCA, give the series code which is stamped or etched on the PCA

5-4. PARTS AND SCHEMATICS

The HP-IB Interface Assembly Parts Lists, Parts Location, and Schematics are provided on the following pages of this section.

TABLE 5-1. HP-IB INTERFACE ASSMEBLY (07970-62465), PARTS LIST

REF.DES./ INDEX NO.	DESCRIPTION	PARTS NO.
1	ASSY: CONTROL	07970-62454
2	ASSY: FORMATTER	07970-62455
3	PCA: CONN ADAPTOR	07970-62453
4	PCA: SWITCH ADAPTOR	07970-62372
5	PANEL: HPIB BACK	07970-01293
6	ASSY: CABLE	8120-3417
7	CABLE ASSY: HPIB INT	8120-3701
8	CABLE ASSY: INTERCONN	8120-3699
9	CABLE ASSY: WRT MOTHERBD	8120-3700
10	CABLE ASSY: HPIB CONTROL	8120-3702
11	CABLE: HPIB POWER CON	07970-62379
12	WASHER: FL#6 .156"D	3050-0228
13	SCREW: 6-32x.312POS	2360-0115
15	STANDOFF: HEX M/FM	0380-0644
16	WASHER: #10SPL LOCK	2190-0034
17	STANDOFF: 6-32	0380-2250
U48	IC;NANO PROC 8-B	1820-1692

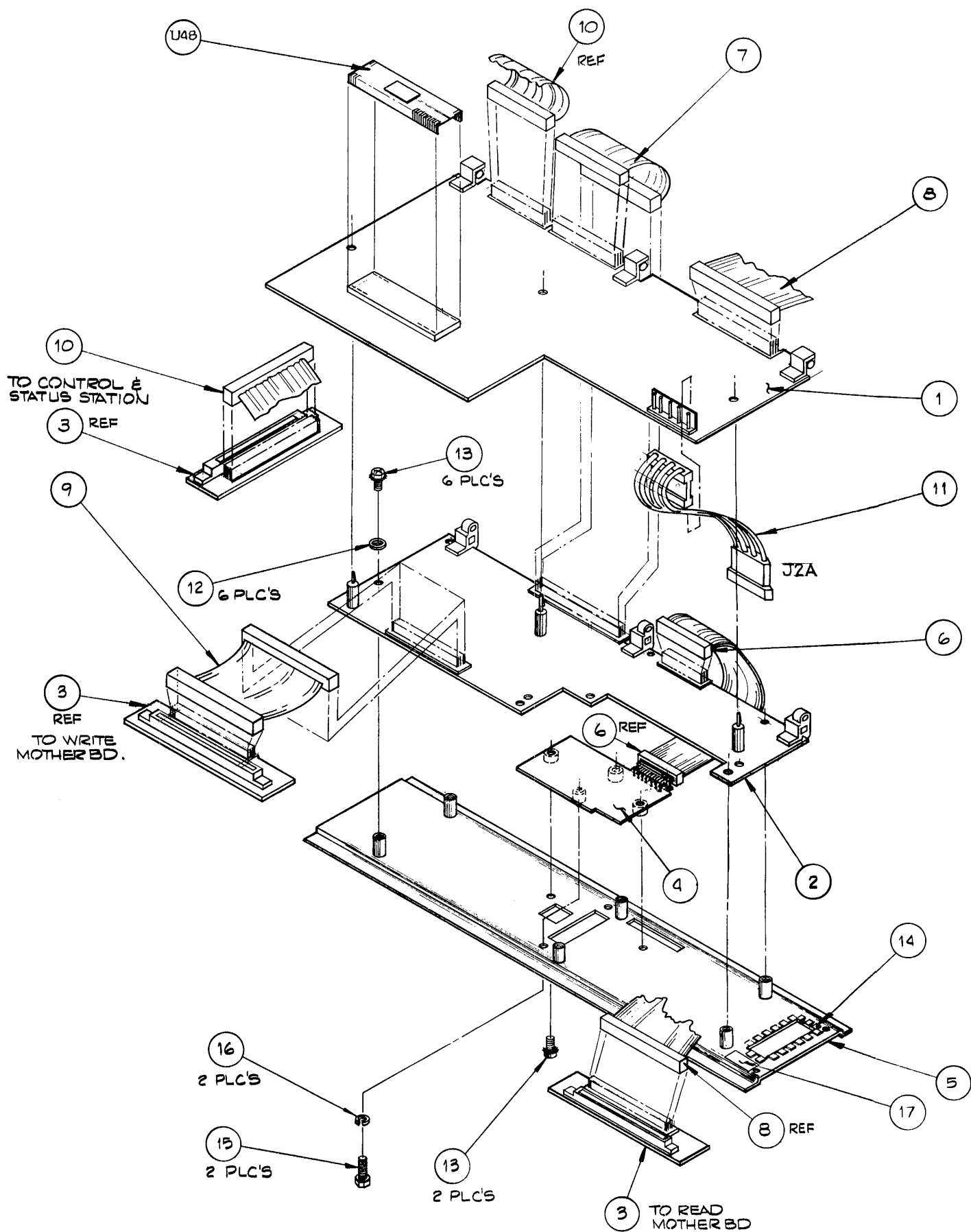


Figure 5-1. HP-IB Interface Assembly (07970-62456), Exploded View

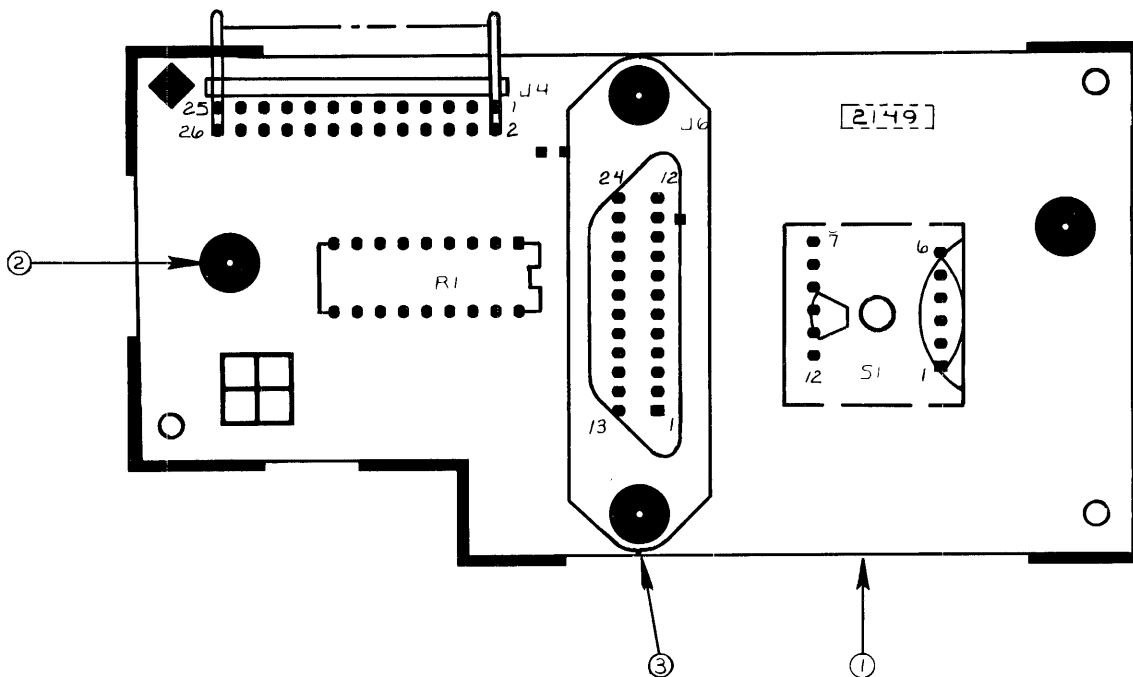


Figure 5-2. Switch Adaptor PCA (07970-62372), Parts Location

TABLE 5-2. SWITCH ADAPTOR PCA (07970-62372), PARTS LIST

REF. DES./ INDEX NO.	DESCRIPTION	PART NO.
1	PCB SWITCH	07970-82372
2	SPCR:RVT #6X.250	0380-0111
3	STDF:RVT #6X.188	0380-0390
J4	CONN 26-PIN M	1251-5448
J6	CONN:24 PIN F	1251-4040
R1	N:R 16X3K/6.2K	1810-0408
S1	SW:THWHL 1-MOD	3100-3480

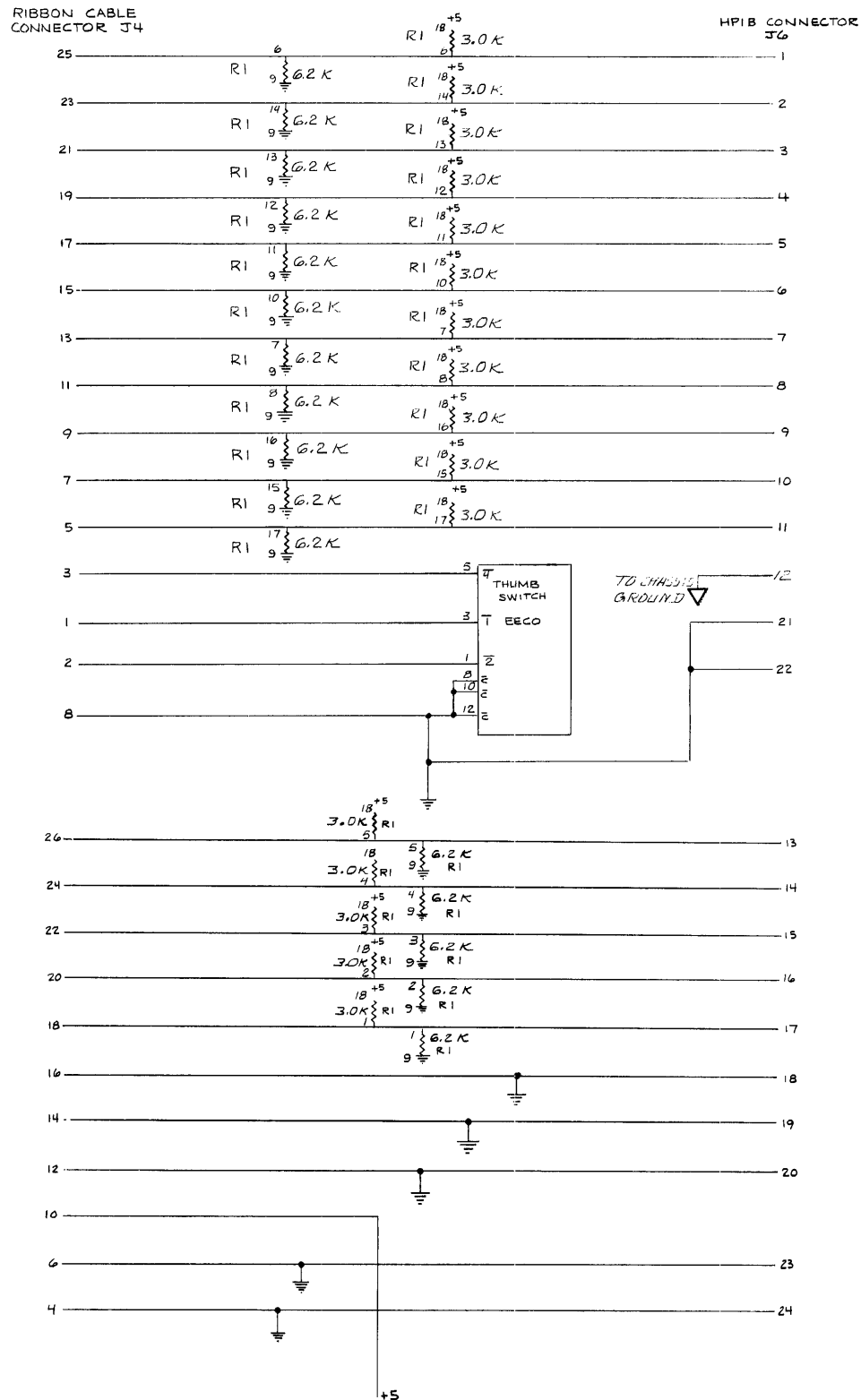


Figure 5-3. Switch Adaptor PCA (07970-62372), Schematic

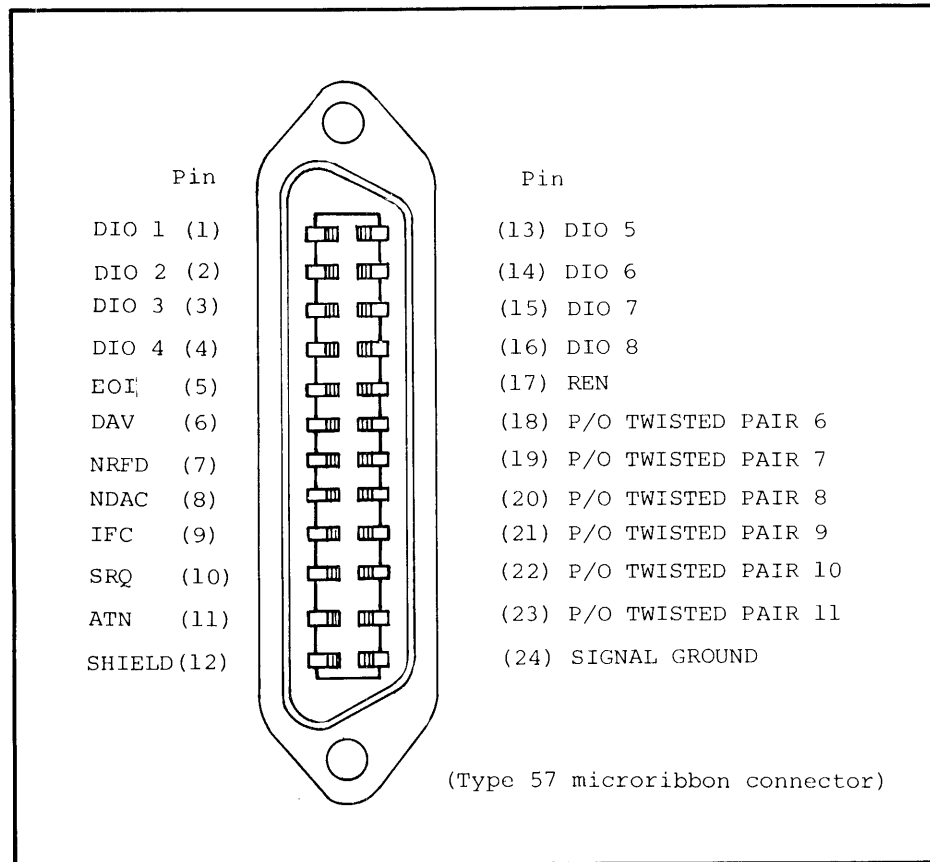
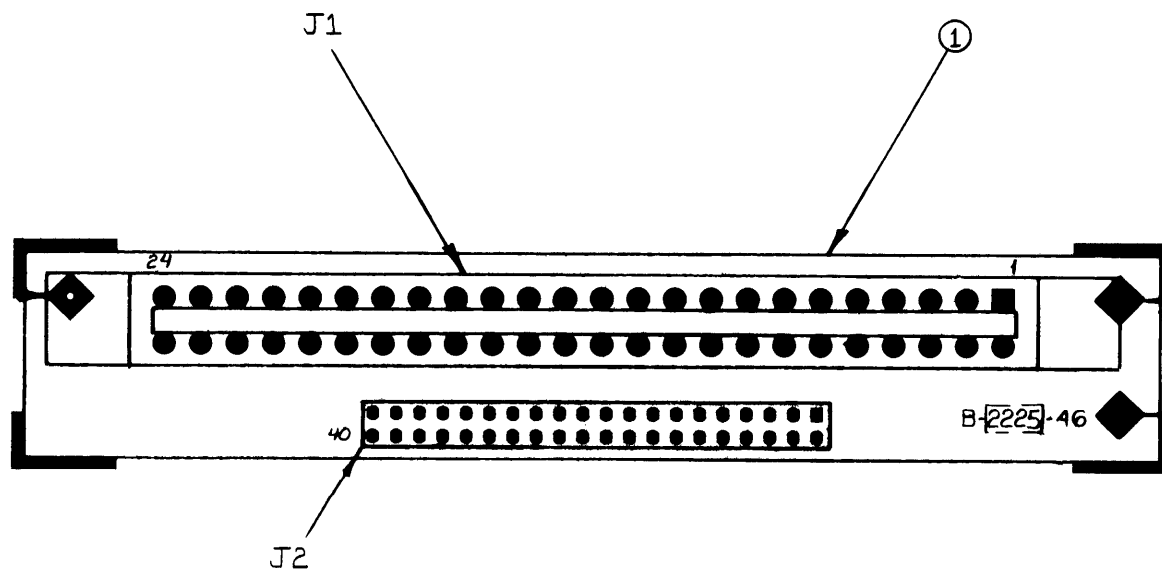


Figure 5-4. HP-IB Connector (J6)



07970-62453 SCHEMATIC

THE 07970-62453 PCA CONNECTS THE FOLLOWING PINS TOGETHER:

J2-	TO	J1-
1		1X
2		1
3		2X
4		2
5		3X
6		3
7		4X
8		4
9		5X
10		5
11		6X
12		7X
13		8X
14		8
15		9X
16		9
17		10X
18		10
19		11X
20		11
21		12X
22		12
23		13X
24		13
25		14X
26		14
27		15X
28		15
29		16X
30		16
31		17X
32		17
33		18X
34		19X
35		20X
36		21X
37		22X
38		23X
39		23
40		24X

Figure 5-5. Connector Adaptor PCA (07970-62453), Diagram

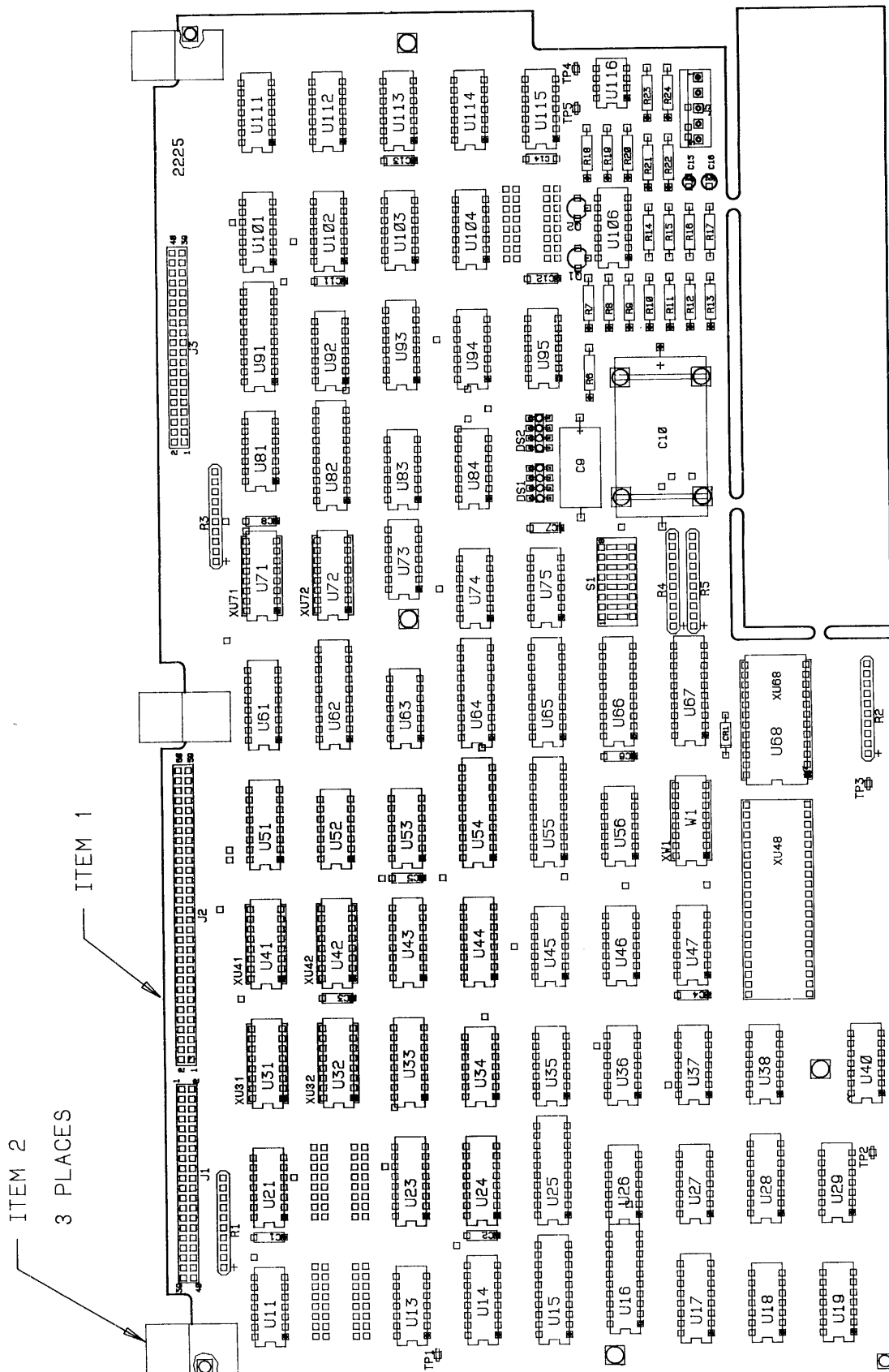


Figure 5-6. Control PCA (07970-62454), Parts Location

TABLE 5-3. CONTROL PCA (07970-62454), PARTS LIST

REF. DES./ INDEX NO.	DESCRIPTION	PART NO.
1	PCB:CONTROL	07970-82454
2	HINGE	5040-7787
C1-8,11-14	C:F.01UF20% DIP	0160-5298
C9	C:F100UF 10V 10%	0180-2207
C10	CAPACITOR-FIXED	0180-3235
C15	C:F2.2UF20%15VDC	0180-0575
C16	C:F3.3UF20%35VDC	0180-2794
CR1	DIO:SW 1N4150	1901-1098
DS1,2	LED-LMP ARY 5MA	1990-0652
J1,J3	CONN:40 PIN	1251-7895
J2	CONN:60 PIN	1251-7894
J5	CONN 5-PIM M	1251-5506
Q1	XSTR:PNP 2N3906	1853-0036
Q2	XSTR:NPN 2N3904	1854-0215
R1,3,4	N:R9X1.5K2%.125W	1810-0276
R2,5	N:R9X10K 2%.125W	1810-0280
R6	R:F 3900 5% .25	0683-3925
R7	R:F 560 5% .25W	0683-5615
R8,20-22,24	R:F 4.64K 1%.125	0698-3155
R9	R:F 16.2K1%.125W	0757-0447
R10	R:F 22 5% .25W	0683-2205
R11,19	R:F 680K 5% .25W	0683-6845
R12	R:F 316K 1% .125	0698-3457
R13	R:F 1K1% .125W F	0757-0280
R14	R:F 237K 1% .125	0698-3266
R15,16	R:F28.7K 1% .125	0698-3449
R17	R:F 1.47K1%.125W	0757-1094
R18	R:F 47K 5% .25	0683-4735
R23	R:F 34.8K 1%.125	0757-0123
S1	SW:RKR 8-1A .05A	3101-1983
TP1-5	TERM:TST PT-BRAS	0360-0535
U11,21,84	IC:SN7407N BUFFR	1820-0668
U13,45,94,102	IC:SN74LS04N	1820-1199
U14,23,24	IC:SN74LS138N	1820-1216
U15,25,54,55,91	IC:SN74LS273N	1820-1730
U16,62,66,82	IC:SN74LS244N	1820-2024
U17,28,51,61	IC:SN74LS257AN	1820-1438
U18,19,27,29	IC:SN74LS393N	1820-2096

TABLE 5-3. CONTROL PCA (07970-62454), PARTS LIST Cont.

REF. DES. / INDEX NO.	DESCRIPTION	PART NO.
U26,34-36,40, 73-75,81,111, 112,114,115	IC:SN74LS74N	1820-1112
U31,32,41,42, 71,72	IC NMOS4K 4096-B	1818-0093
U33,43,44,93	IC SN74LS395	1820-1446
U37	IC:SN74LS20N GAT	1820-1204
U38	IC:SN74LS10N	1820-1202
U46	IC:SN74LS14N	1820-1416
U47,56	IC:SN74LS38N BFR	1820-1209
U52,104	IC:SN74LS11 GATE	1820-1203
U53,83	IC:SN74LS00N	1820-1197
U63,95,103	IC:SN74LS08N	1820-1201
U64,65	IC:SN74LS374N	1820-1997
U67	IC:SN74LS245N	1820-2075
U68	PROM ASSY	07970-62457
U92,101	IC:SN74LS51N GAT	1820-1210
U106	IC:339 CMPTR-GP	1826-0138
U113	IC:SN74LS54N GAT	1820-1285
U116	IC:MC1403U V-REG	1826-0544
W1	N:COND MDL 16-P	1810-0307
XU31,32,41,42, 71,72	SCKT IC 16-CONT	1200-0607
XU48	SCKT-IC 40-CONT	1200-0883
XU68	SCKT:24 PIN IC	1200-0541

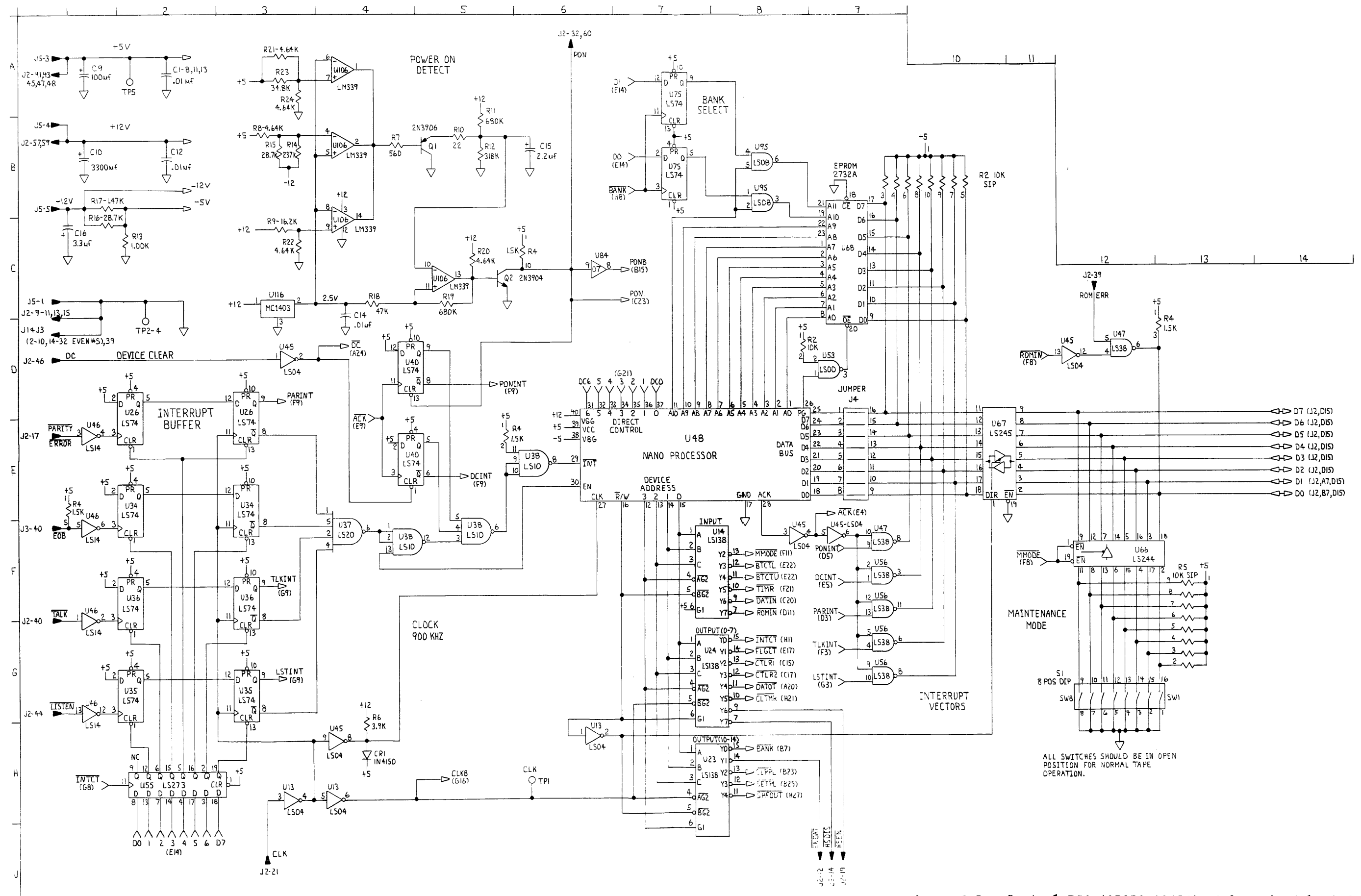


Figure 5-7. Control PCA (07970-62454), Schematic (Sheet 1 of 3)

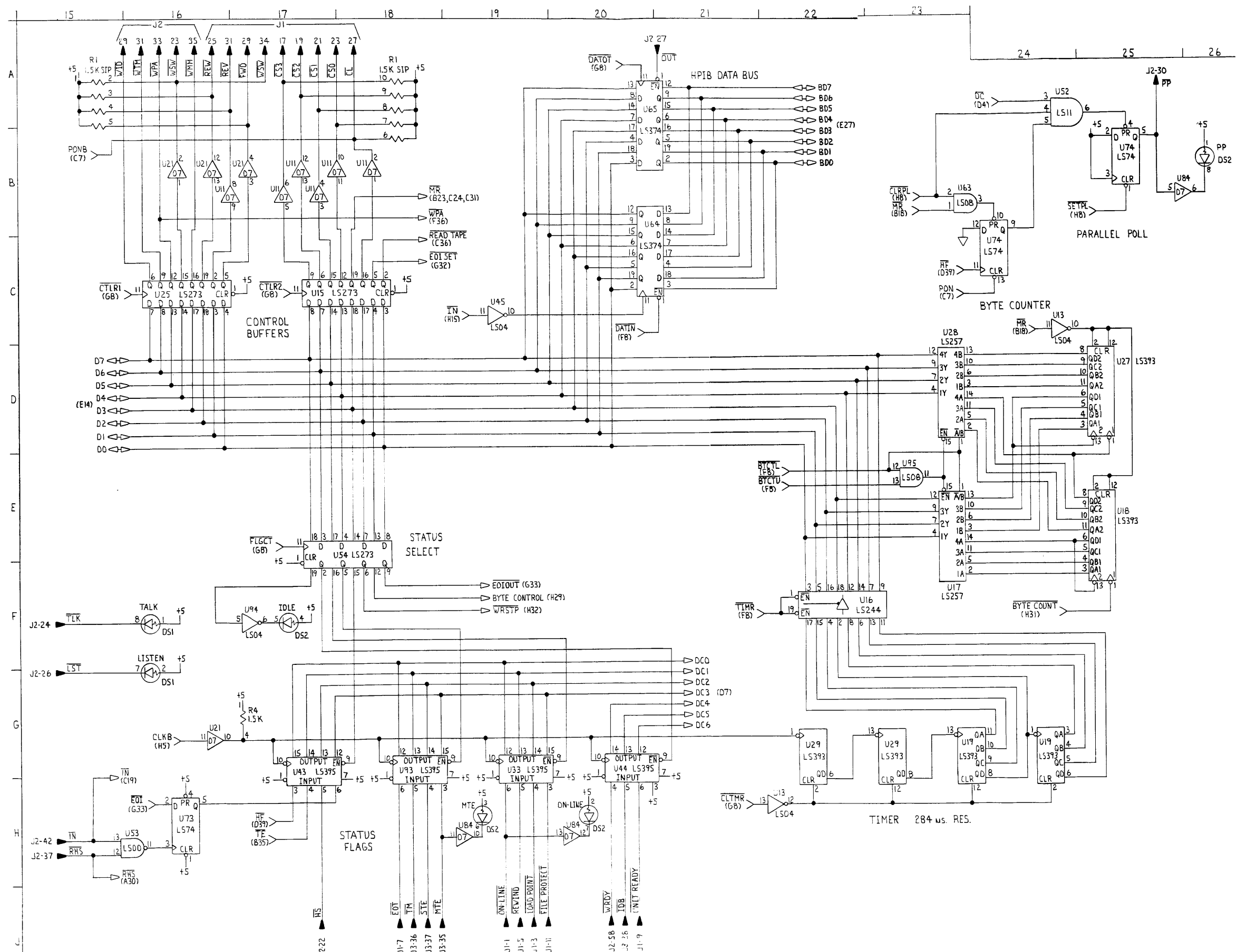


Figure 5-7. Control PCA (07970-62454), Schematic (Sheet 2 of 3)

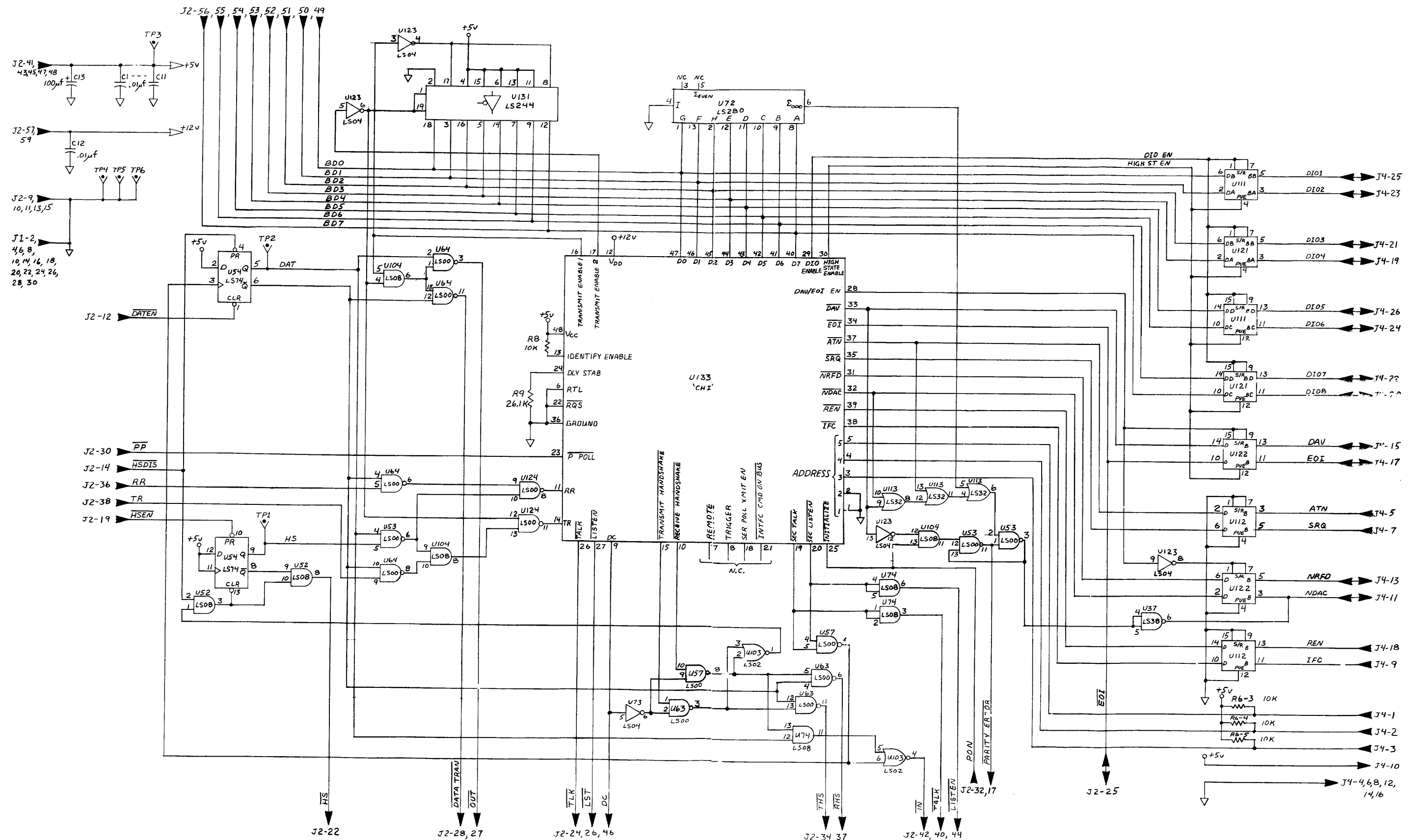


Figure 5-9. Formatter PCA (07970-62455), Schematic (Sheet 1 of 3)

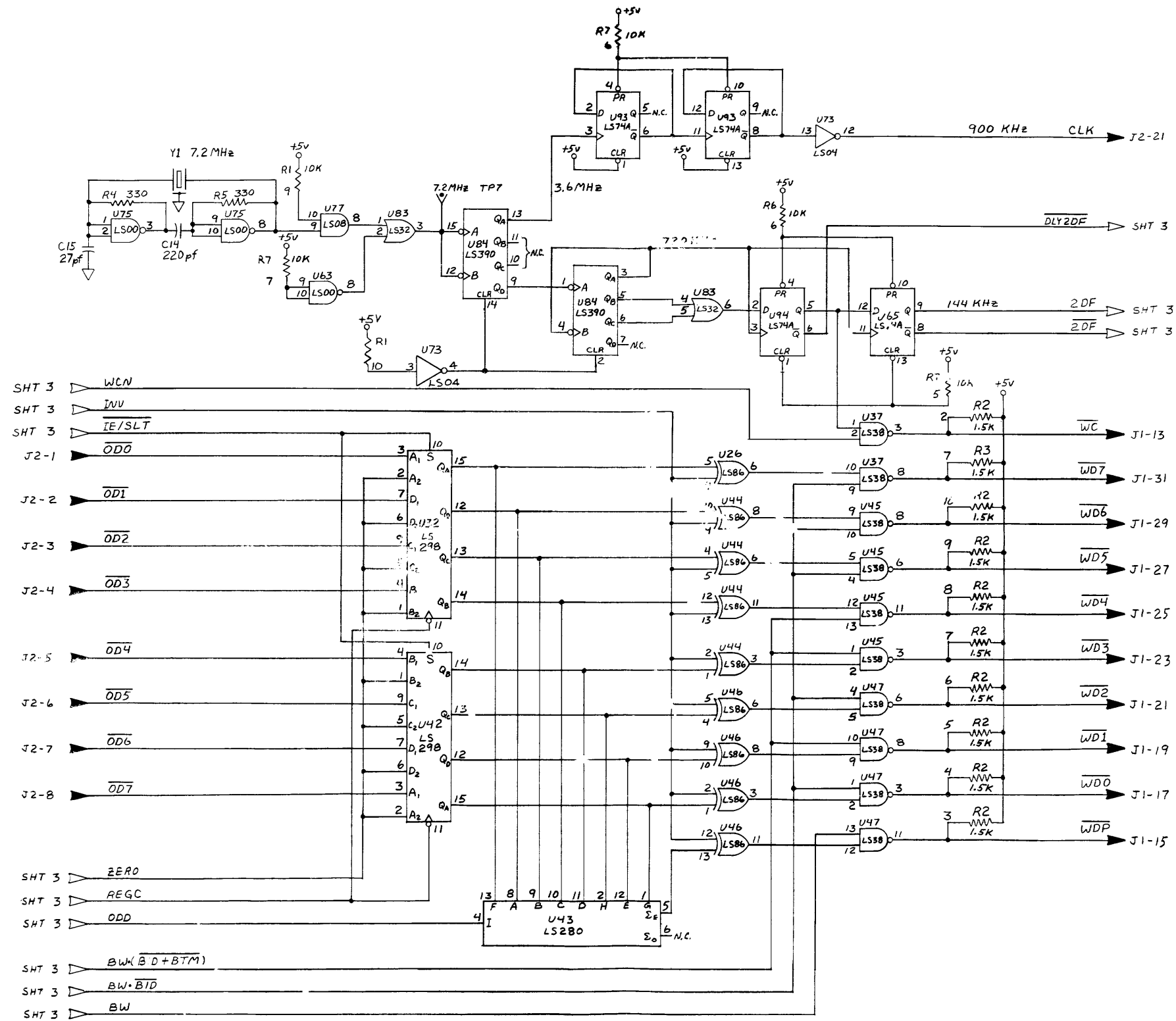
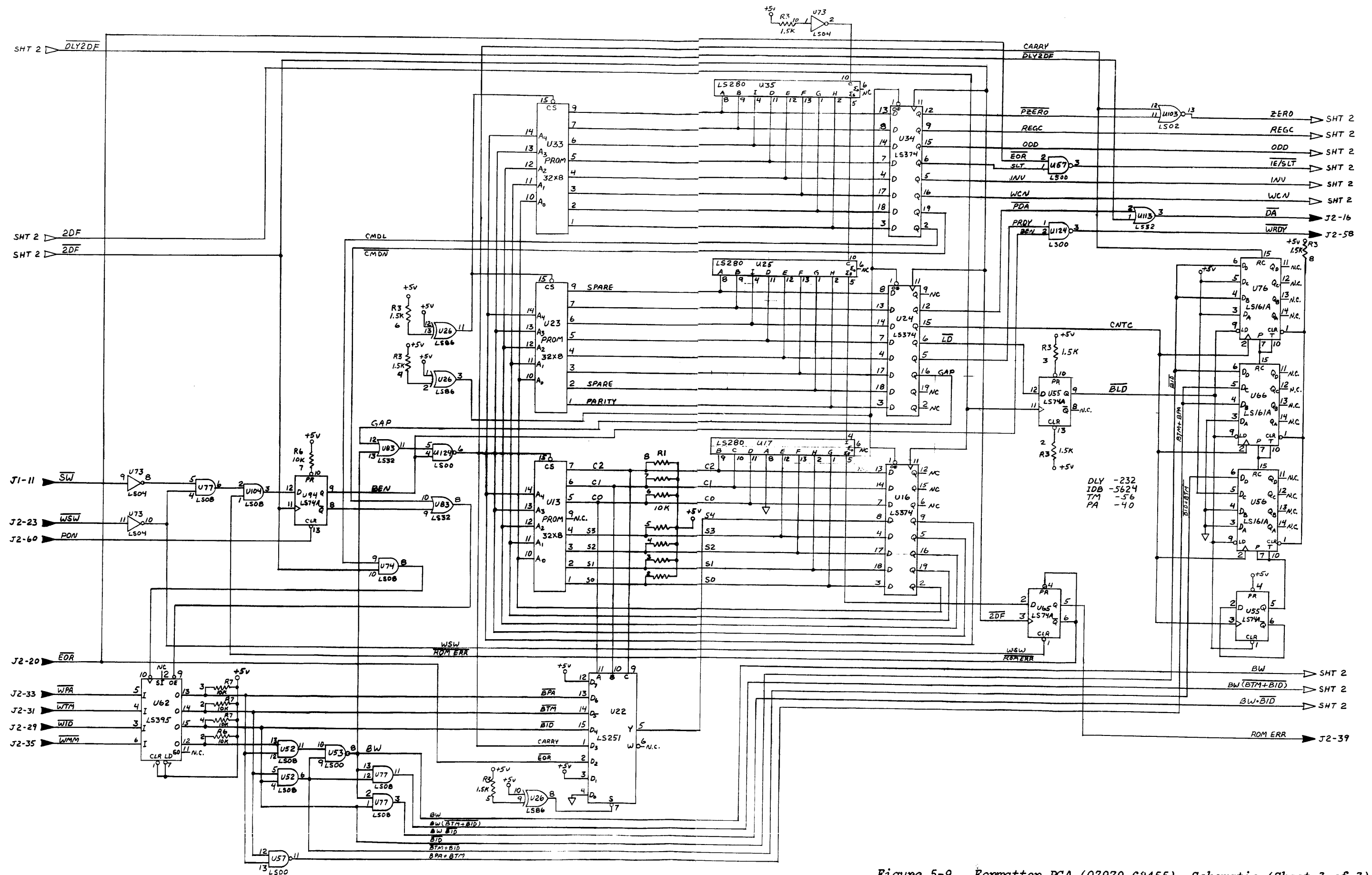


Figure 5-9. Formatter PCA (07970-62455), Schematic (Sheet 2 of 3)



APPENDIX A. PROGRAMMING TABLES

A-1. INTRODUCTION

Appendix A summarizes programming information from section II (Programming) into tables for easy reference. The type of information contained in each table is listed below, along with the table reference.

- * Tape Unit Identify Bytes. A-1
- * Listen Secondary Commands A-2
- * Talk Secondary Commands A-3
- * Tape Command Secondary, Data Byte A-4
- * End Command Secondary, Data Byte. A-5
- * DSJ Command Secondary Data Byte A-6
- * Status Command Secondary, Data Byte A-7

TABLE A-1. TAPE UNIT IDENTIFY BYTES

DIO LINE	8	7	6	5	4	3	2	1
BYTE 1	1	1	0	0	0	0	0	1
BYTE 2	1	0	0	0	0	0	0	1

TABLE A-2. LISTEN SECONDARY COMMANDS

SECONDARY COMMAND	VALUE (DIO LINES)	DESCRIPTION
DATA TRANSFER	X1100000	Data bytes to follow represent data to be written to tape.
TAPE COMMAND	X1100001	Data bytes to follow represent a tape command to be performed by the tape unit.
END COMMAND	X1100111	Data byte to follow represents an End command (see table A-5).
DEVICE CLEAR	X1110000	This command resets the interface, any data bytes that may follow are accepted by the interface, but are ignored.
LOOPBACK	X1111111	Data bytes that follow represent data (64 bytes) to be saved for loopback transfer back to the system controller.

X = Parity Bit

TABLE A-3. TALK SECONDARY COMMANDS

SECONDARY COMMAND	VALUE (DIO LINES)	DESCRIPTION
DATA TRANSFER	X1100000	Data bytes to follow represent data to be read from tape.
STATUS COMMAND	X1100001	Three data bytes that follow represent the status from the three status registers.
BYTE COUNT	X1100010	The two data bytes that follow represent the number of bytes read/written for the last record. The first data byte is the most significant value.
DSJ STATUS	X1110000	The data byte that follows represents the Device Specified Jump status (see table A-7).
LOOPBACK	X1111110	Data bytes that follow represent the loopback bytes sent to the sent to the interface with the Loopback talk command.

X = Parity Bit

TABLE A-4. TAPE COMMAND SECONDARY, DATA BYTE

VALUE (OCTAL)	COMMAND	VALUE (OCTAL)	COMMAND
0	RESERVED	10	READ RECORD
1	SELECT UNIT 0	11	FORWARD SPACE RECORD
2	SELECT UNIT 1	12	BACKSPACE RECORD
3	SELECT UNIT 2	13	FORWARD SPACE RECORD
4	SELECT UNIT 3	14	BACKSPACE FILE
5	WRITE RECORD	15	REWIND
6	WRITE FILE MARK (EOF)	16	REWIND AND GO OFF-LINE
7	WRITE GAP	17	READ RECORD BACKWARD

TABLE A-5. END COMMAND SECONDARY, DATA BYTE

DIO LINE	COMMAND
1	CLEAR POLL RESPONSE
2	INHIBIT POLL RESPONSES FOR READ BURSTS
3	ENABLE REWIND COMPLETION RESPONSE OR AUTO-SELECT
4	RESERVED
5	CLEAR DSJ
6,7,8	RESERVED

The command is enabled when the DIO line corresponding to the command is set to 1.

TABLE A-6. DSJ COMMAND SECONDARY DATA BYTE

BYTE VALUE	DESCRIPTION
0	NO SPECIAL ACTION REQUIRED
1	UNEXPEDTED RESULTS; READ STATUS

TABLE A-7. STATUS COMMAND SECONDARY DATA BYTE

STATUS BYTE 1 - REGISTER 1

DIO LINE	STATUS
1	ON-LINE
2	MULTIPLE TRACK ERROR(S) (MTE)
3	FILE PROTECTED (Not Write Enabled; no write ring)
4	COMMAND REJECTED
5	SINGLE-TRACK ERROR
6	END-OF-TAPE (EOT)
7	LOAD POINT (LP) (Beginning-of-tape - BOT)
8	END-OF-FILE (EOF)

STATUS BYTE 2 - REGISTER 2

DIO LINE	STATUS
1	INTERFACE BUSY
2	TAPE UNIT BUSY
3	REWINDING
4	TAPE RUNAWAY
5	DATA ERROR (TIMING)
6	SELECTED TAPE UNIT LSB
7	SELECTED TAPE UNIT MSB
8	RESERVED

STATUS BYTE 3 - REGISTER 3

DIO LINE	STATUS
1	TAPE UNIT 0 HAS BEEN PLACED ON-LINE
2	TAPE UNIT 1 HAS BEEN PLACED ON-LINE
3	TAPE UNIT 2 HAS BEEN PLACED ON-LINE
4	TAPE UNIT 3 HAS BEEN PLACED ON-LINE
5	COMMAND PARITY ERROR
6	POWER HAS BEEN RESTORED
7	RESERVED
8	RESERVED

When the DIO line is set 1, the corresponding status is indicated

APPENDIX B.

BACKDATING INFORMATION

B-1. INTRODUCTION

Appendix B provides backdating information for older versions of the 7970E HP-IB Interface Assembly. The information included here covers replacement parts, parts location diagrams, and schematics for older versions of the assembly. Table B-1, below identifies the various older interface assemblies described in this section and references them to the current assembly part numbers.

TABLE B-1. BACKDATING INFORMATION

ASSEMBLY	CURRENT PART NO.*	OLDER VERSION PART NO.*	NOTES
TOP LEVEL	62456	62417, 62381	For 62381, refer to 62417
CONTROL PCA	62454	62416, 62369	For 62369, refer to 62416
FORMATTER PCA	62455	62370	
SWITCH ADAPTOR PCA	62372	62372	Older version is similar to current version, refer to 62372, section 5
POWER SEQUENCE PCA		62407	Current version is been incorporated onto the 62454 PCA

* - The "07970-" part number prefix has been deleted from the listed part numbers.

TABLE B-2. HP-IB INTERFACE ASSEMBLY (07970-62417), PARTS LIST

REF. DES. / INDEX NO.	DESCRIPTION	PART NO.
1	PCA:HPIB CONTROL	07970-62416
2	PCA:WRT FORMATER	07970-62370
3	PCA:CONN ADPTR	07970-62371
4	PCA:SW ADAPTER	07970-62372
5	PNL:HPIB BACK	07970-01293
6	ASSY:CABLE	8120-3417
7	ASSY:CABLE	8120-3408
8	ASSY:CABLE	8120-3405
9	ASSY:CABLE	8120-3407
10	ASSY:CABLE	8120-3406
11	CBL:HPIB PWR CON	07970-62379
13	SCR:6-32X.312POZ	2360-0115
15	STDOFF:HEX M/FM	0380-0644
16	WSHR:#10SPL LOCK	2190-0034
17	STANDOFF, 6-32	0380-1150
19	N:COND MDL 16-P	1810-0307
20	GROM-CHN .085GRV	0400-0207
U39	CHI	1AA7-6003
U91	IC:NANO PROC 8-B	1820-1692
XS1	SHUNT-DIP 7 POS	1251-4292
W1,2	SUNT:1-PIN ST.1L	1258-0124

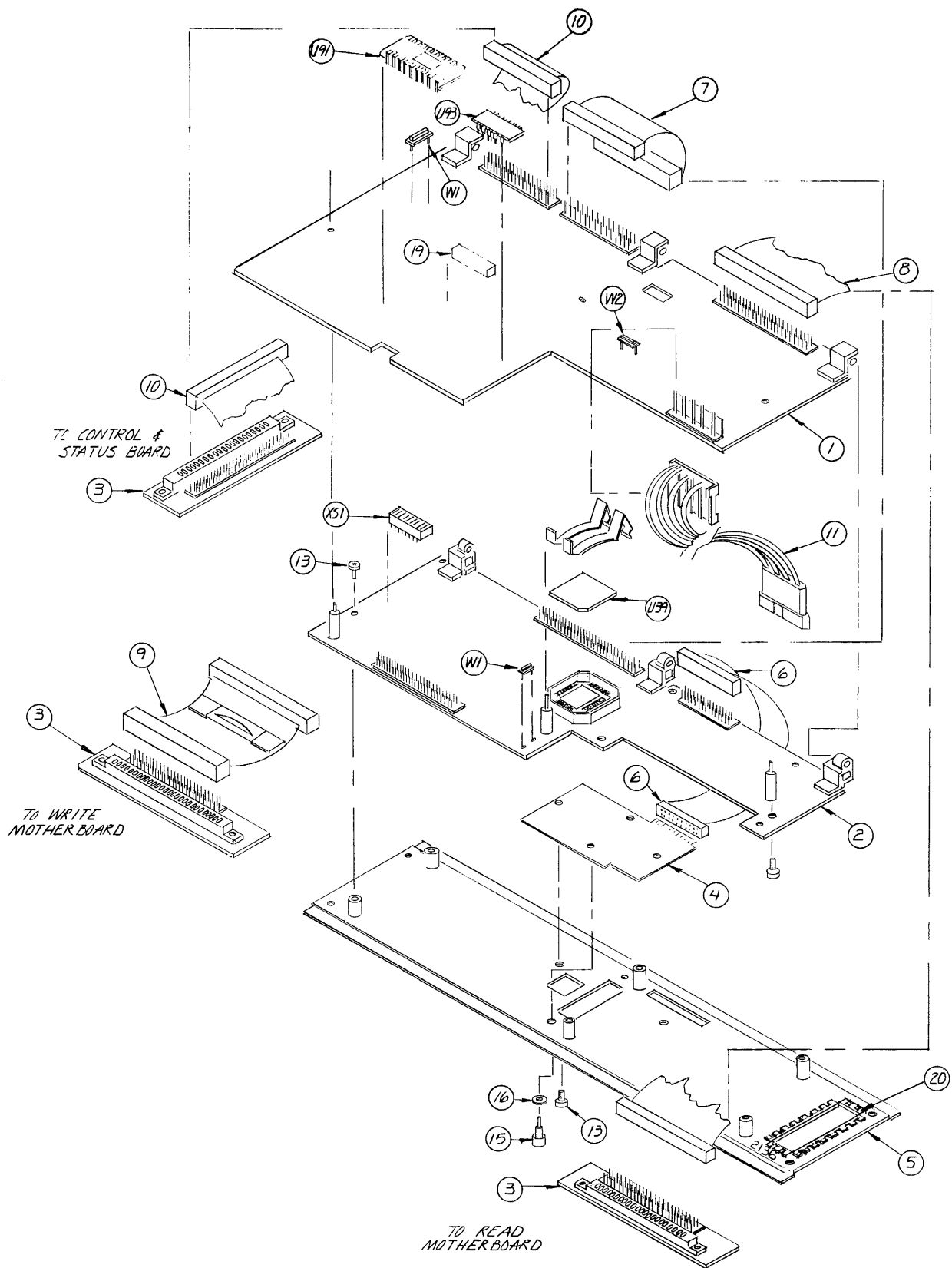


Figure B-1. HP-IB Interface Assembly (07970-62417), Exploded View

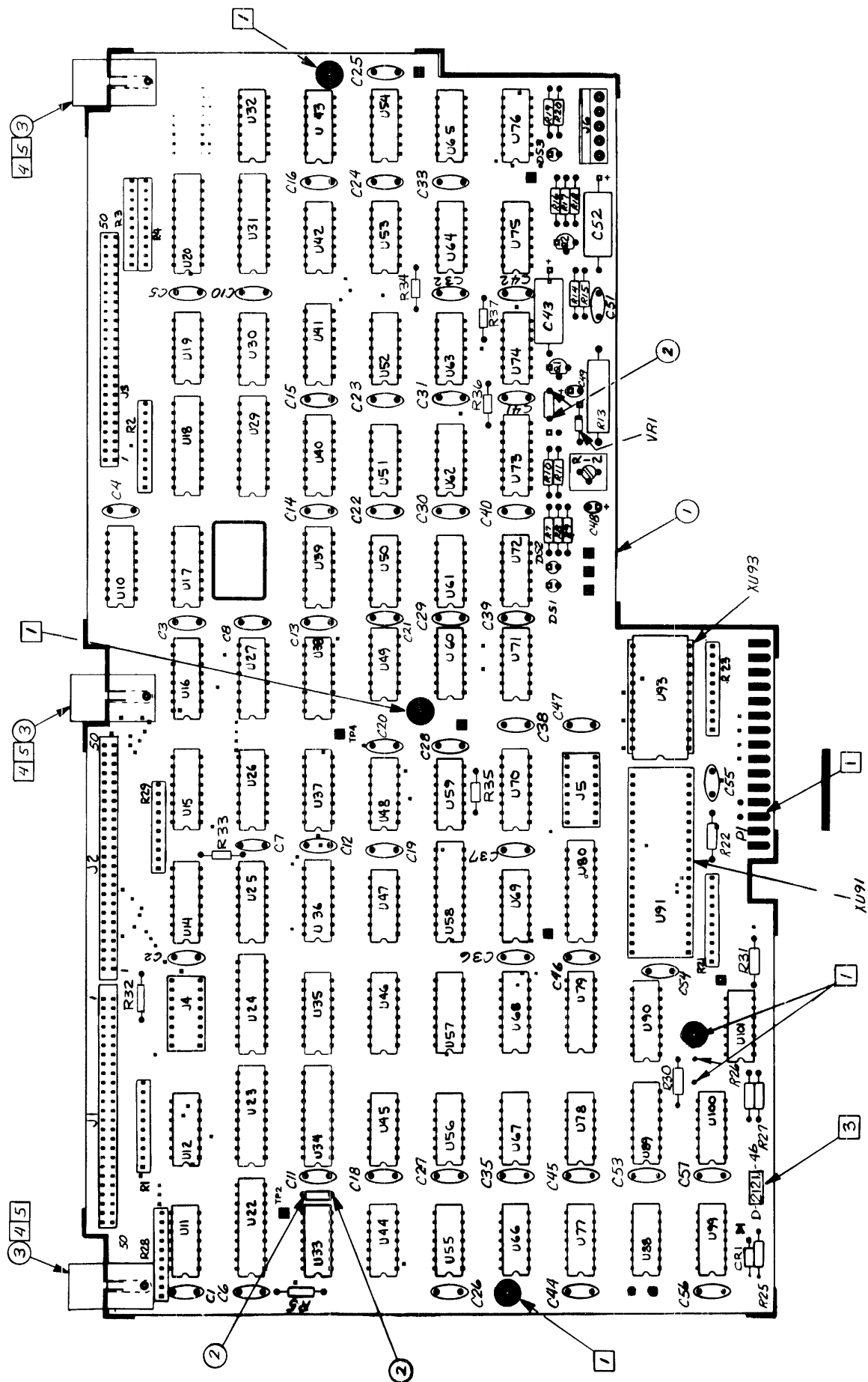


Figure B-2. Control PCA (07970-62416), Parts Location

TABLE B-3. CONTROL PCA (07970-62416), PARTS LIST

REF. DES./ INDEX NO.	DESCRIPTION	PART NO.
1	HPIB PCB	07970-82416
2	CNNCTR-SGL CNTCT	1251-5440
4	HINGE	5040-7787
C1-8,10-16, 18-33,35-42, 44-47,51,53-57	C:F.01UF+80%100V	0160-2055
C43	C:F100UF 10V 10%	0180-2207
C48-49	C:F3.3UFTANT 15V	0180-2664
C52	C:F68UF10%15VDC	0180-2692
CR1	DIO:SW 1N4150	1901-1098
J1,2,3	CONN 50-PIN M	1251-5544
J4,5	SOCKET IC 16-CON	1200-0423
J6	CONN 5-PIM M	1251-5506
Q1	XSTR:PNP 2N3906	1853-0036
Q2	XSTR:NPN 2N3904	1854-0215
R1-4,21,23,28, 29	N:R9X10K 2%.125W	1810-0280
R5,9-11,19,22, 25-27,30,31, 33-37	R:F 10K5% .25W	0683-1035
R7,8,20	R:F 220 5% .25W	0683-2215
R12	R:V TRMR 1K 10%	2100-3211
R13	R:F 1.21K 1% .5W	0757-0821
R14,18	R:F 1K5% .25W	0683-1025
R15	R:F 2.2K5% .25W	0683-2225
R16	R:F 1.5K 5% .25W	0683-1525
R17	R:F 4.7K5% .25W	0683-4725
R32	R:F 3900 5% .25	0683-3925
S1,2,3	LED:LAMP 50MA RD	1990-0404
TP1-9,GND1-3	CONN-SGL CONT	0360-1813
U10,17,38-41	IC NMOS4K 4096-B	1818-0093
U11,12,19,30	IC:SN7407N BUFR	1820-0668
U14,15,25,26,35, 46,57,68,79	IC SN74LS395	1820-1446
U16,27	IC:SN74LS157	1820-1470
U18,22-24,34	IC:SN74LS273N	1820-1730
U20,29,31,58	IC:SN74LS244N	1820-2024
U33,42,53,59,60	IC:SN74LS04N	1820-1199

TABLE B-3. CONTROL PCA (07970-62416), PARTS LIST Cont.

REF. DES. / INDEX NO.	DESCRIPTION	PART NO.
U36,37	IC:SN74LS257AN	1820-1438
U43-45,56,62, 64-67,74,75,78	IC:SN74LS74N	1820-1112
U47,48,69	IC: SN74393N	1820-1464
U49,51	IC:SN74LS51N GAT	1820-1210
U50,32,55,72	IC:SN74LS11 GATE	1820-1203
U52,54	IC:SN74LS08N	1820-1201
U61,76,77	IC:SN74LS38N BFR	1820-1209
U63,100,101	IC:SN74LS00N	1820-1197
U70,73	IC: SN74LS390N	1820-1991
U71	IC:SN74LS21N	1820-1205
U80	IC:SN74LS245N	1820-2075
U88	IC:SN74LS14N	1820-1416
U89,90	IC:SN74LS138N	1820-1216
U99	IC:SN74LS05	1820-1200
VR1	DIO:ZNR6.19V 5%	1902-0049
XU91	SCKT-IC 40-CONT	1200-0883
XU93	SCKT:24 PIN IC	1200-0541

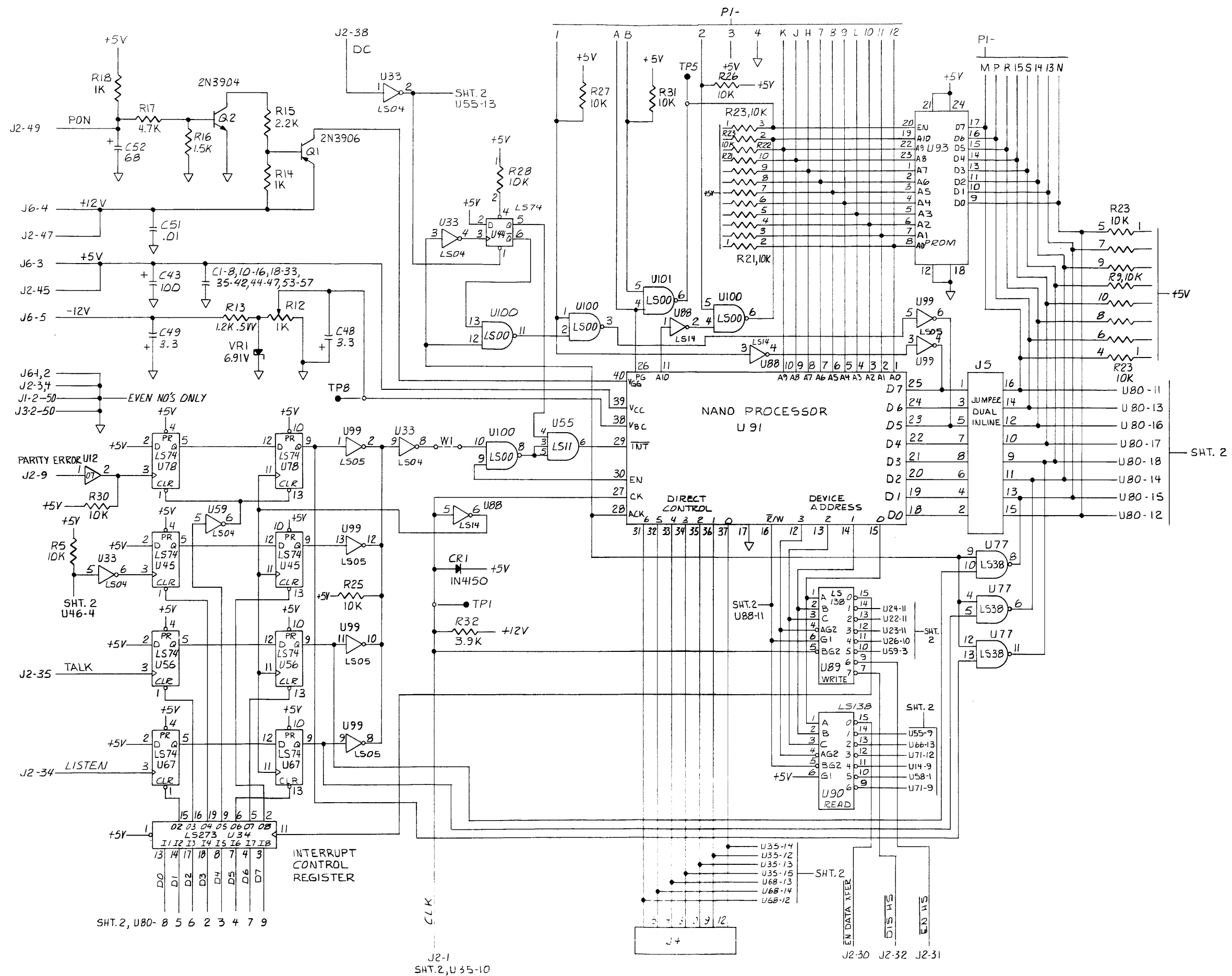


Figure B-3. Control PCA (07970-62416), Schematic (Sheet 1 of 3)

Figure B-3. Control PCA (07970-62416), Schematic (Sheet 2 of 3)

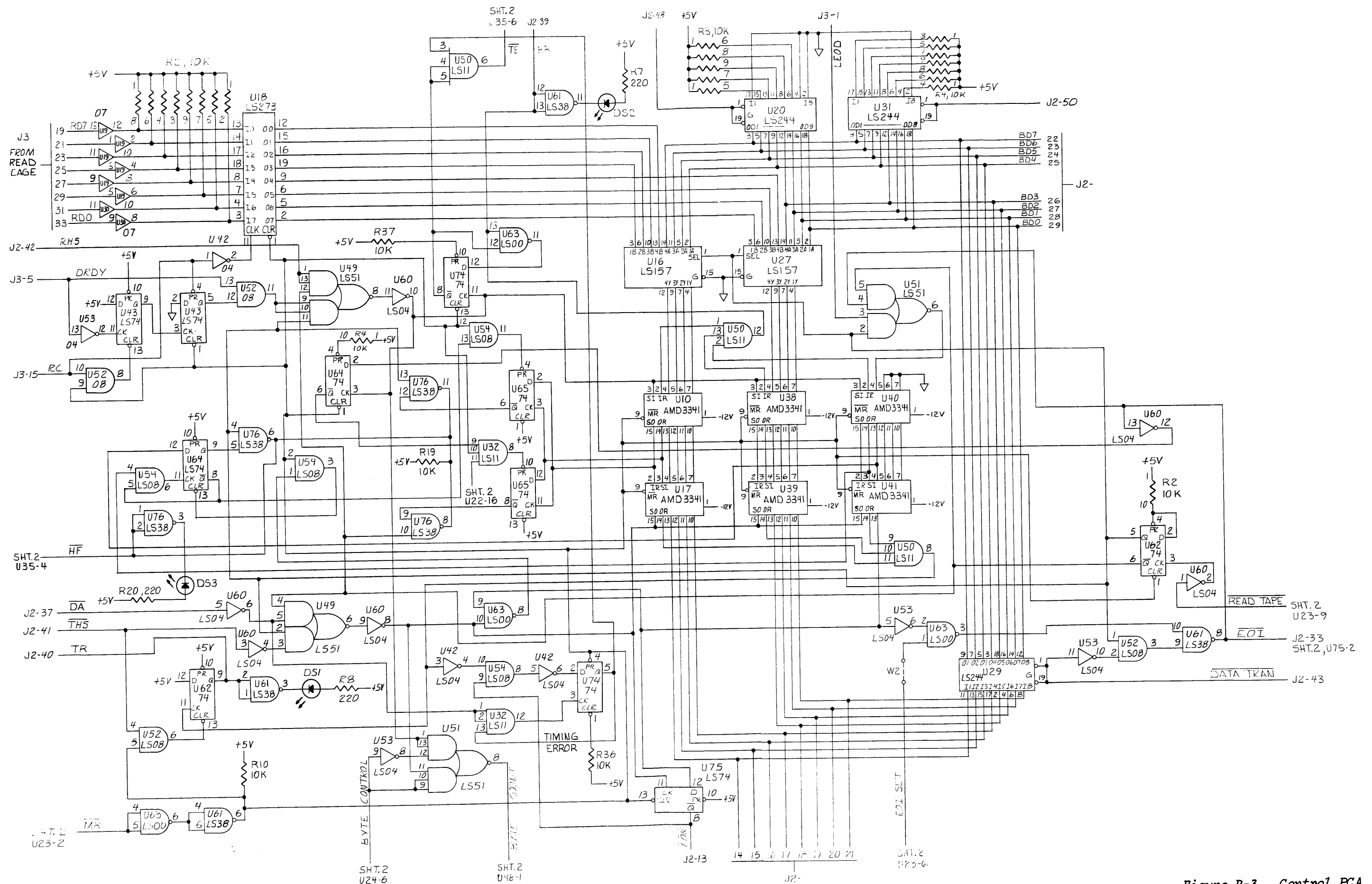


Figure B-3. Control PCA
(07970-62416), Schematic (Sheet 3 of 3)

TABLE B-4. FORMATTER PCA (07970-62370), PARTS LIST

REF. DES. / INDEX NO.	DESCRIPTION	PART NO.
1	PCB FORMATER	07970-82370
2	CNNCTR-SGL CNTCT	1251-5440
5	HINGE	5040-7721
6	SPACER;SNAP IN	0380-0630
7	SCR:6-32X.312POZ	2360-0115
C1-3,6-8,11,12, 14-30,32-34, 36,37	C:F.01UF+80%100V	0160-2055
C4,31	C:F100UF 10V 10%	0180-2207
C9	C:F 220PF 5%	0160-0134
J1,2	CONN 50-PIN M	1251-5544
J3	SOCKET IC 16-CON	1200-0423
J4	CONN 26-PIN M	1251-4605
R1,11	R:F 330 5% .25W	0683-3315
R2,28	N:R9X2.2K2%.125W	1810-0277
R3	R:F26.1K 1% .125	0698-3159
R4-10,15,19,23, 24,29,30	R:F 10K5% .25W	0683-1035
R12	R:F 13.3K 1%.125	0757-0289
R16,17	R:F 1K5% .25W	0683-1025
R18	R:F 14.7K1%.125W	0698-3156
R20,21	R:F 220 5% .25W	0683-2215
R25	R:F 47K 5% .25	0683-4735
R31	R:F 5.11K1%.125W	0757-0438
R32	R:F 7.5K1% .125W	0757-0440
S1,2,3,4	LED:LAMP 50MA RD	1990-0404
TP1-9;	CONN-SGL CONT	0360-1813
U12,23	IC: SN74LS390N	1820-1991
U13,27,49	IC:SN74LS74N	1820-1112
U21,45,53,70	IC:SN74LS04N	1820-1199
U22	IC:SN74LS11 GATE	1820-1203
U24,35,46,61,68, U25,29,36,43,62, 69,75	IC:SN74LS112 F-F	1820-1212
U26,42,54,58,64	IC:SN74LS00N	1820-1197
U30	IC:SN74LS08N	1820-1201
U33	IC:SN74LS05	1820-1200
U34	IC:SN74160N CNTR	1820-0899
	IC SN74LS123N	1820-1423

TABLE B-4. FORMATTER PCA (07970-62370), PARTS LIST Cont.

REF. DES. / INDEX NO.	DESCRIPTION	PART NO.
U37	IC:SN74LS32N	1820-1208
U38,50	IC: SN74LS298N	1820-1444
U40,41,51,52	IC: MC3448AL	1820-2058
U44	IC:SN74LS38N BFR	1820-1209
U47	IC:SN74LS190N CN	1820-1279
U48	IC:SN74LS54N GAT	1820-1285
U56	IC:SN74LS138N	1820-1216
U57	IC:SN74LS21N	1820-1205
U59,66,73	IC:SN74LS86N	1820-1211
U60	IC:SN74180N GNRT	1820-0435
U63	IC:SN74LS02N	1820-1144
U65,72,76	IC:SN7438N BUFR	1820-0621
U67	IC:SN74LS280N	1820-1859
U71	IC:SN74LS10N	1820-1202
U74	IC:SN74LS27N	1820-1206
U77	IC:SN74LS28N BUF	1820-1273
XU39	SKT-SBSTR48-CONT	1200-0847
Y1	XTAL 7.2MHZ	0410-0449

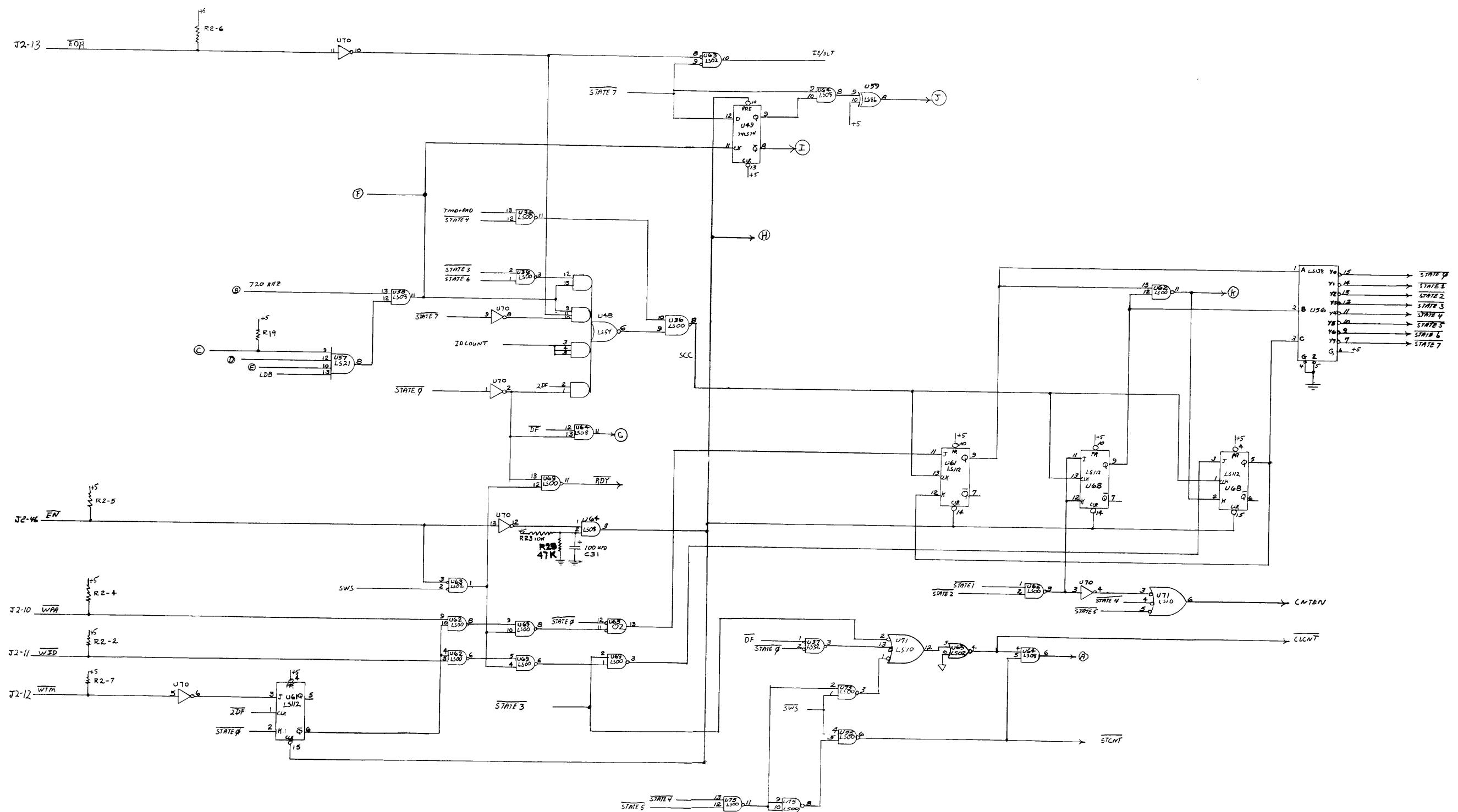


Figure B-5. Formatter PCA
(07970-62370), Schematic (Sheet 1 of 3)

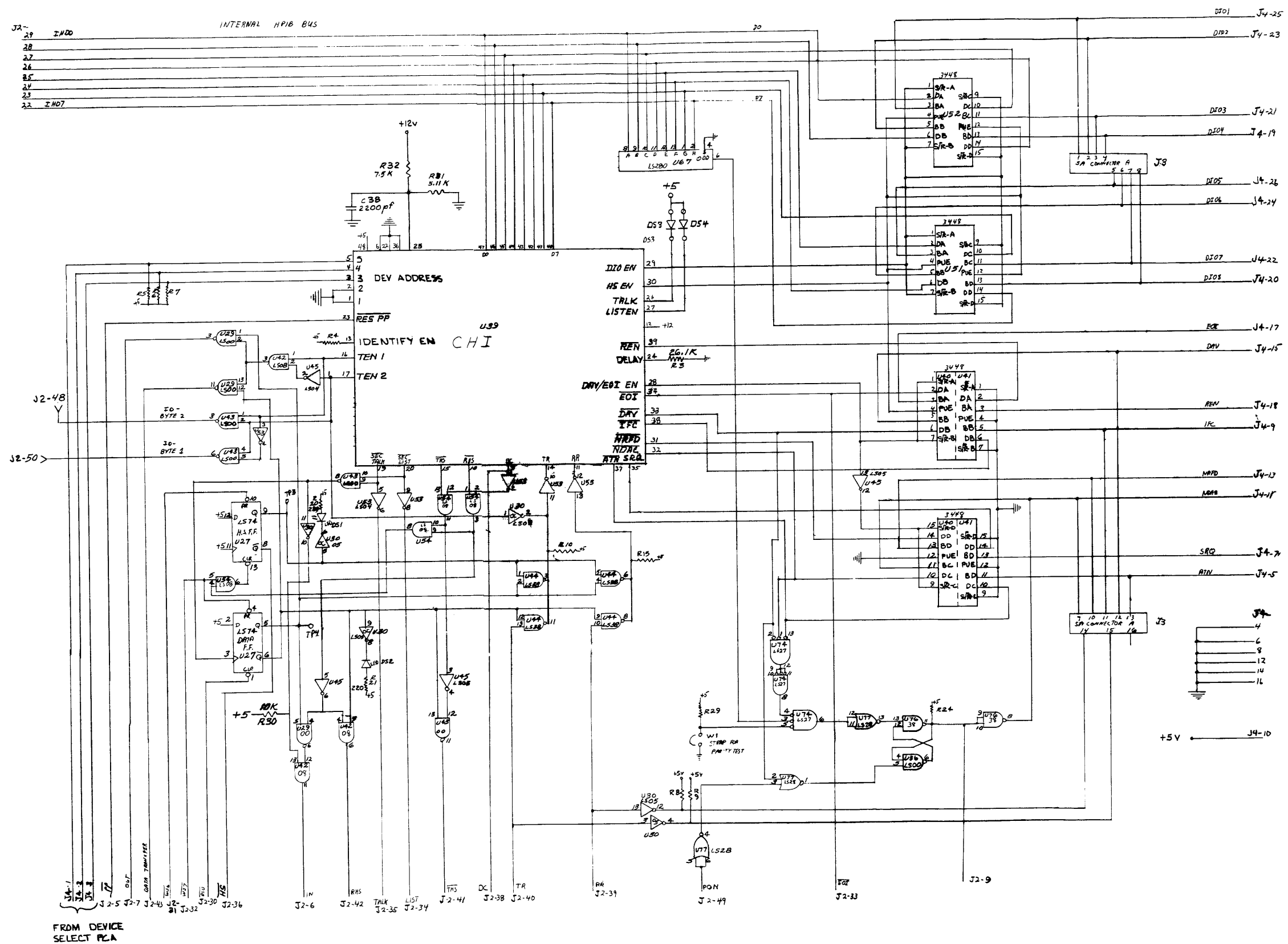


Figure B-5. Formatter PCA
(07970-62370), Schematic (Sheet 3 of 3)

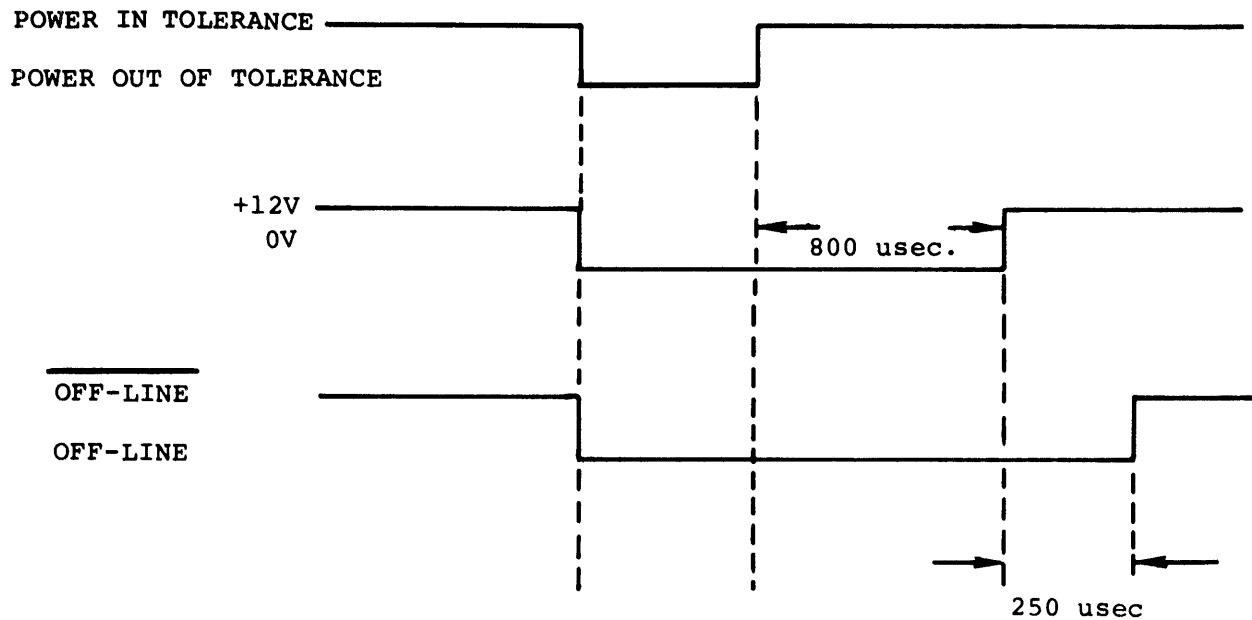


Figure B-7. Power Sequence PCA (07970-62407), Timing Diagram

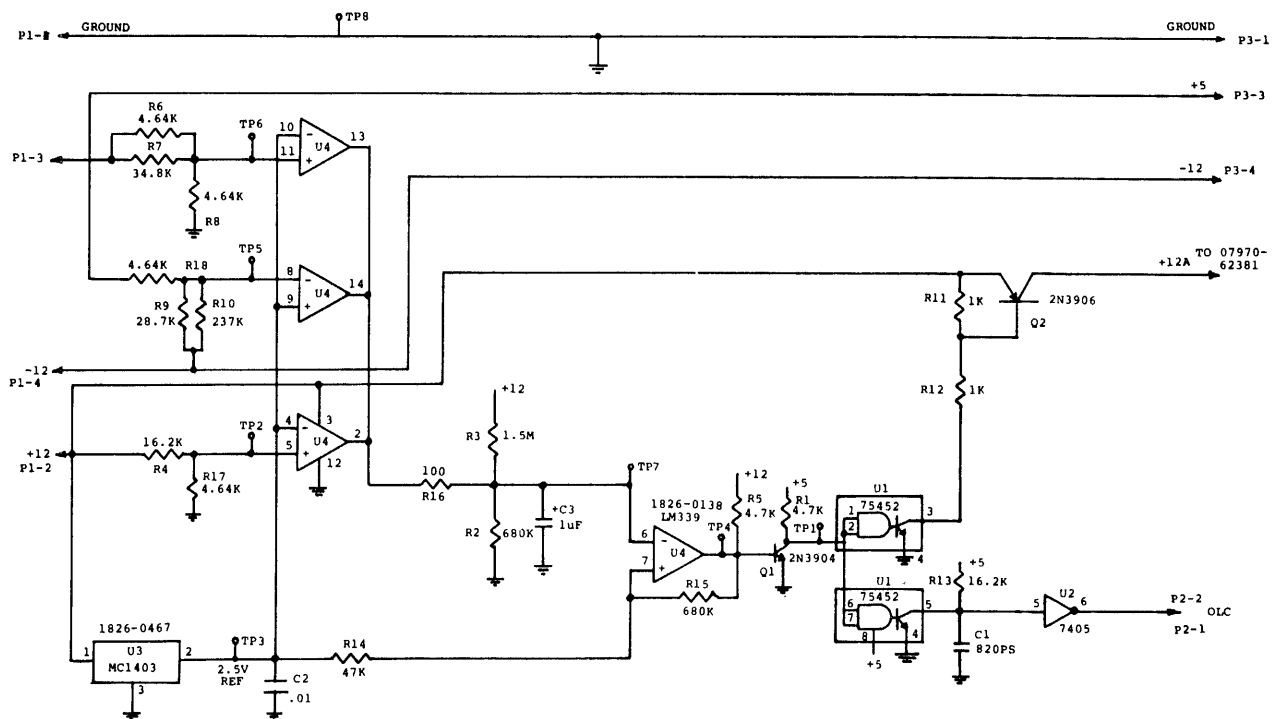


Figure B-8. Power Sequence PCA (07970-62407), Schematic

TABLE B-5. POWER SEQUENCE PCA (07970-62407), PARTS LIST

REF. DES./ INDEX NO.	DESCRIPTION	PART NO.
1	PWR SEQ PCB	07970-82407
2	SPCR:RVT #6X.250	0380-0111
4	CLIP-CMPNT1-1/8L	1400-0040
5	RVT:S .123DX.156	0361-0142
C1	C:F 820PF 5%	0160-2009
C2	C:F.01UF+80%100V	0160-2055
C3	C:F 1UF 20%35VDC	0180-2764
C4	C:F 3000UF 10%	0180-2395
J1	CONN 4-PIN MOLEX	1251-5728
J2	CONN 3-PIN MOLEX	1251-5251
J3	CONN 4-PIN MOLEX	1251-5727
Q1	XSTR:NPN 2N3904	1854-0215
Q2	XSTR:PNP 2N3906	1853-0036
R1,5	R:F 4.7K5% .25W	0683-4725
R2,15	R:F 680K 5% .25W	0683-6845
R3	R:F 1.5M 5% .25W	0683-1555
R4,13	R:F 16.2K1%.125W	0757-0447
R6,8,17,18	R:F 4.64K 1%.125	0698-3155
R7	R:F 34.8K 1%.125	0757-0123
R9	R:F28.7K 1% .125	0698-3449
R10	R:F 237K 1% .125	0698-3266
R11,12	R:F 1K5% .25W	0683-1025
R14	R:F 47K 5% .25	0683-4735
R16	R:F 100 5% .25W	0683-1015
TP1-8	TERM:SGL-TUR	0360-1682
U1	IC:SN75452BP	1820-0799
U2	IC:SN7405N INVTR	1820-0175
U3	IC:MC1403U V-REG	1826-0544
U4	IC:339 CMPTR-GP	1826-0138

